DOCUMENT RESUME

ED 051 991 **SE 007 484**

AUTHOR	Fornoff, Frank J.
TITLE	A Survey of the Teaching of Chemistry in Secondary Schools.
INSTITUTION	Educational Testing Service, Princeton, N.J.
REPORT NO	TDR-69
PUB DATE	May 69
NOTE	92p.
AVAILABLE FROM	Educational Testing Service, 20 Nassau Street, Princeton, New Jersey 08540
EDRS PRICE	EDRS Price MF-$0.65 HC Not Available from EDRS.
DESCRIPTORS	*Chemistry, College Entrance Examinations, *Educational Background, *Evaluation, National Surveys, Science Courses, *Secondary School Science, *Tests
IDENTIFIERS	College Entrance Examination Board, Educational Testing Service

ABSTRACT

This study was conducted to obtain educational background information of secondary school students who take the College Board Chemistry Achievement Test. In 1965-66, data were gathered from 49,752 students who took the CEEB Chemistry Achievement Test. Questionnaires from 2,395 of these students were studied primarily for (1) the types of chemistry courses offered, (2) textbooks used, (3) topics studied, (4) time allotted, and (5) other secondary school courses taken. Findings indicated that despite the many variables involved, the content of secondary school chemistry did not vary greatly. Five fundamental topics were consistently taught in nearly all of these chemistry courses. Results supported the concept of nationwide chemistry achievement tests. [Not available in hardcopy due to marginal legibility of original document.] (RR)

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TEST DEVELOPMENT REPORT
TDR-69-5 MAY 1969

A Survey of the Teaching of Chemistry in Secondary Schools

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Frank J. Fornoff
Test Development Division, ETS

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A SURVEY OF THE TEACHING OF CHEMISTRY IN SECONDARY SCHOOLS

Preface

Probably more changes have occurred in secondary school curriculums during the past ten years than in any previous decade in our nation's history. The impact of these changes on the academic preparation of college-bound students is of concern to the College Entrance Examination Board, which prepares achievement tests for college admissions programs. To obtain factual information on what individuals actually study in secondary school, the College Entrance Examination Board supported a survey of about 38,000 students who took College Board achievement tests during the 1965-66 academic year. These students represented more than 7,500 secondary schools throughout the United States.

Before the survey was initiated, the question of whether or not students both could and would give valid accounts of their educational experiences was investigated. The results of this feasibility study, which was conducted in about 50 secondary schools for seniors studying French and chemistry, showed a satisfactorily high agreement between teachers' and students' responses to the same questions. As might be expected, agreement was highest in the most recent grades. However, even as far back as grade 9, there was a mean student-teacher agreement of 70 per cent. In the case of highly factual questions, percentages ranged from 90 to 100. Interviews carried on in a selected sample of these 50 schools showed that student responses to questions that they understood were valid even in the case of recall over three and four years.

At the outset, these data were to be used only for developing better achievement tests. However, as the study progressed, their potential usefulness to a wider audience of educators became more apparent. The fact that College Board achievement tests are taken by only a fraction of college entrants is an inherent limitation in the use of these data. However, extensive information such as that collected for this study is highly relevant to many current issues in secondary education.

Consequently, Educational Testing Service is publishing these results in a series of eight reports, one in each of the following subjects: English, history, biology, chemistry, physics, mathematics, Latin, and modern foreign languages (French, German, and Spanish). The author of each of these reports is an examiner in the subject field in the Test Development Division of Educational Testing Service. Special consultants assisted these authors in identifying the findings in each field that would be of the greatest importance and interest to the educational community. Details of the study design and administration appear in Appendix I.

Elizabeth W. Haven
Project Director

Acknowledgments

The author wishes to express appreciation to the numerous people who made valuable contributions in connection with the preparation of this report. A few people who merit particulat mention include the following:

Mr. Edmond Lonsky, Chairman of the Science Department, Plainfield, New Jersey, High School who served as the consultant for the planning of the report and who reviewed it during its preparation.

Mrs. Elizabeth W. Haven who supervised the preparation of the data, reviewed the report, and has exhibited sustained interest in its appearance.

The members of the Committee of Examiners for the College Board Chemistry Achievement Test who made suggestions for the initial questionnaire, about the treatment of the resulting data, and for the improvement of the report.

Messrs. Richard L. Burns, Miles McPeek, and Robert Boldt who performed careful reviews of it.

Mrs. Camille Nini who devoted much effort to its preparation.

Mrs. Gertrude Sanders, Mrs. Ruth Edmonds, and Mrs. Dorothea Fisher, each of whom with her special talents contributed in important ways.

Introduction

Although the Committee of Examiners for the Chemistry Achievement Test of the College Entrance Examination Board have the benefit of a number of professional services, they lack one thing that every school teacher who prepares his tests does have: information about the students who are to take the test.

To minimize the effects of this deficiency, a survey was conducted. Details of the design are given in Appendix I.

Questions about which information is provided by the results of the survey include the following:

> Are students who take the College Board Chemistry Achievement Test typical of the country's secondary school chemistry students?
>
> Are the students who take the test in December and January like those who take it in March and in May?
>
> What is the educational background of the students who take the test?
>
> What science courses have the students who take the test completed?
>
> What percentage of the students have had two secondary school chemistry courses?
>
> What is the nature of these courses?
>
> What topics are considered by these students in their courses?
>
> How much time each week is devoted to chemistry instruction?
>
> How much of this time is spent in the laboratory?

The introduction of the new courses, developed at least in part with the assistance of National Science Foundation grants, has increased the uncertainty about the nature of the populations for the Chemistry Achievement Test. The report provides the Examiners with some information on the students from these courses. Others interested in secondary school chemistry courses and their students will also find the information worth considering.

I. Description of the Candidate Population

The College Board Chemistry Achievement Test is offered five times a year. Table I-1 gives the number of candidates at each of the administrations and the school grades of the candidates. The data are for the year 1965-66, the year in which the questionnaires were collected.

TABLE I-1

Number of Candidates Taking the CEEB Chemistry Achievement Test by Administration and Grade Level, 1965-66

	July 1965	December 1965	January 1966	March 1966	May 1966	Totals 1965-66
Eleventh Grade	6,691	137	234	1,300	20,821	29,183
Twelfth Grade	706	10,499	11,756	6,676	2,684	32,321
All Others	1,072	399	613	827	2,582	5,493
Total	8,469	11,035	12,603	8,803	26,087	66,997

The decision was made to limit the survey to candidates who took the test at the four administrations during the school year. More than eighty-five per cent of the Chemistry Achievement Test candidates are included in these four administrations. A further limitation was that only the questionnaires of candidates from the dominant class at each of the administrations would be considered. For the December, January, and March administrations these are the twelfth-graders, and in May they are eleventh-graders. Furthermore, in the belief that the December and the January seniors are much alike, questionnaires for the secondary school seniors from these two administrations were combined.

Table I-2 gives the sizes of the candidate populations sampled and the sizes of the samples.

TABLE I-2

Sizes of the CEEB Chemistry Achievement Test Populations Sampled and the Number of Questionnaires Studied

	Number of Test Candidates	Number of Questionnaires Studied	Sample Percentages
December-January Seniors	22,255	1,331	5.98
March Seniors	6,676	386	5.78
May Juniors	20,821	678	3.26

Because of the differences in the sample percentages, information from the three administrations is usually not combined in the tables in this report.

Several of the following tables give information on the students who take the test. Table I-3 gives the description by sex of the respondents and of all of the College Board Chemistry Achievement Test candidates for 1965-66.

TABLE I-3

Sex of the Three Groups of Questionnaire Respondents and of CEEB Chemistry Achievement Test Candidates

	Respondents		Chemistry Achievement Test Candidates	
	Boys	Girls	Boys	Girls
December-January Seniors	1,077 80.9%	254 19.1%	18,162 82.0%	3,981 18.0%
March Seniors	288 74.6%	98 25.4%	5,063 76.4%	1,561 23.6%
May Juniors	503 74.2%	175 25.8%	15,754 75.9%	5,006 24.1%
Total Questionnaire Respondents	1,868 78.0%	527 22.0%		
Total 1965-1966 Chemistry Test Candidates			52,457 77.6%	15,266 22.4%

These data indicate that the respondent samples are similar to the total Chemistry Achievement Test population as far as percentages of boys and girls are concerned although in each of the three groups that were sampled the girls seem to have been a little more willing to complete the questionnaires than were the boys.

The respondents have also been classified according to the type of secondary school which they attended and the region of the country from which they came. Data on these classifications are contained in Table I-4.

TABLE I-4

Number of Questionnaire Respondents by Administration, by Type of Secondary School, and by Region of the Country

		Students	Percentages
December-January Seniors			
Public Schools		1064	80
Roman Catholic Schools		211	16
Other Schools[1]		56	4
	Total	1331	100
Northeast[2]		701	53
South[3]		135	10
Midwest[4]		312	23
West[5]		183	14
	Total	1331	100
March Seniors			
Public Schools		291	75
Roman Catholic Schools		83	22
Other Schools		12	3
	Total	386	100
Northeast		103	27
South		39	10
Midwest		205	53
West		39	10
	Total	386	100
May Juniors			
Public Schools		466	69
Roman Catholic Schools		100	15
Other Schools		112	17
	Total	678	101
Northeast		496	74
South		61	9
Midwest		68	10
West		53	8
	Total	678	101

---

[1] Many but not all of the schools in the category, "Other Schools," are commonly called independent schools.

[2] Northeast: Maine, New Hampshire, Vermont, Massachusetts, Rhode Island,

Table I-5 permits comparisons of the types of schools and the regions of the country from which all secondary school graduates come with these characteristics for the December-January chemistry questionnaire respondents.

TABLE I-5

1964-1965 Secondary School Graduates and December-January Questionnaire Respondents by Type of School and by Region of the Country

	Secondary School Graduates[6]	December-January Questionnaire Respondents
	%	%
Public Schools	93.5	79.9
Nonpublic Schools	6.5	20.1
Northeast	23.6	52.7
South	21.2	10.1
Midwest	30.9	23.4
West	24.4	13.7

Connecticut, New York, Pennsylvania, New Jersey, Delaware, Maryland, District of Columbia

[3] South: Virginia, West Virginia, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, Kentucky, Tennessee, Arkansas

[4] Midwest: Ohio, Indiana, Illinois, Michigan, Wisconsin, Minnesota, Iowa, Missouri, Kansas, Nebraska, South Dakota, North Dakota

[5] West: Oklahoma, Texas, New Mexico, Arizona, California, Nevada, Utah, Colorado, Wyoming, Montana, Idaho, Oregon, Washington

[6] Source: U. S. Department of Health, Education, and Welfare, Office of Education, "Fall 1965 Statistics of Public Schools"; and Office of Education estimates.

The questionnaire respondents are not typical of the country's secondary school seniors: the percentage of nonpublic school students among the respondents is about three times that among secondary school seniors. The percentage of respondents from the Northeast is more than twice that for all secondary school seniors.

The abilities of the respondents to the Chemistry Questionnaire can be judged by their performances on the two parts of the Scholastic Aptitude Test. Table I-6 gives these data for the three groups of respondents based on the month(s) when the Chemistry Achievement Test was taken and within each of these groups for subgroups determined by the type of school and the region of the country. The mean scores for all students of the appropriate secondary school class who took the Scholastic Aptitude Test at the administrations being studied are included for comparison.

TABLE I-6

SAT Scores for Questionnaire Respondents by Month of Taking the Chemistry Achievement Test, by Type of School, by Region of the Country, and for All SAT Candidates of a Certain Secondary School Class at Certain Administrations

	SAT Verbal	SAT Mathematics
December-January Seniors		
All Respondents	552	616
All December 1965 Seniors	479	501
All January 1966 Seniors	456	488
Public Schools	553	620
Roman Catholic Schools	557	603
Other Schools	543	599
Northeast	538	604
South	533	602
Midwest	569	629
West	598	650
March Seniors		
All Respondents	510	576
All March 1966 Seniors	428	449
Public Schools	508	580
Roman Catholic Schools	518	559
Other Schools	504	603
Northeast	507	561
South	521	600
Midwest	505	574
West	532	605
May Juniors		
All respondents	548	598
All May 1966 Juniors	472	501
Public Schools	547	601
Roman Catholic Schools	534	561
Other Schools	565	622
Northeast	541	588
South	567	618
Midwest	570	629
West	577	645

The comparisons between scores for all respondents and scores of all candidates are not completely comparable because the respondents took the Chemistry Achievement Test in the month(s) under which they are listed; however, they may have taken the Scholastic Aptitude Test at another administration. For example, in December 1965, 9,736 candidates took both the Scholastic Aptitude Test and the Chemistry Achievement Test whereas 1,299 took the Chemistry Achievement Test but not the Scholastic Aptitude Test. (For students who took the Scholastic Aptitude Test more than once, the scores obtained closest to the time of analysis in the fall of 1967 were used.)

The table indicates that as judged by SAT scores, the questionnaire respondents were more able than all SAT candidates: more than 70 points in verbal scores and about 100 points or more in quantitative scores. The greater difference in quantitative scores is consistent with the fact that the respondents have taken a science achievement test.

In general, SAT scores of the senior questionnaire respondents were 40 Board scale points higher in December-January than in March. (For all SAT candidates, December scores were 50 points higher than March scores.) Higher scores for December-January seniors is to be expected since the more selective colleges require scores earlier than the March scores are available, and superior candidates apply to these colleges.

The SAT scores of the May junior respondents suggest that they are quite similar to the December-January seniors in ability although the seniors seem to have profited a bit from additional mathematics courses since their quantitative scores are somewhat higher.

When one reviews the scores of the respondents by the type of school attended, he finds that the students from each of the types follow the overall pattern of ability differences. However, it appears that Other School respondents in May are superior in ability to respondents from these schools at other administrations and, in fact, to May respondents from the rest of the schools. Perhaps, independent schools make more of a point of getting superior students registered for May achievement tests than do the non-independent schools.

A look at the scores of the respondents by region of the country shows that the ability of Northeastern respondents is very similar to that of all respondents, a reflection of the preponderence of Northeasterners in the sample. Both senior and junior respondents from the West are superior to those from other regions. Seniors from the South differ less in ability from December-January to March than do the seniors from other parts of the country.

Table I-7 gives the mean scores on the Chemistry Achievement Test for the respondents and for total populations. These data permit one to make an estimate of the ability of the respondents in chemistry as compared to the total Chemistry Achievement Test population of which the respondents constitute a sample.

TABLE I-7

CEEB Chemistry Achievement Test Scores for Questionnaire Respondents and for All Candidates

	Questionnaire Respondents		Test Candidates	
	Mean	Standard Deviation	Mean	Standard Deviation
December-January Seniors	567	105		
December 1965 Seniors			554	106
January 1966 Seniors			548	108
March 1966 Seniors	510	94	511	96
May 1966 Juniors	563	102	552	99

The standard errors of measurement for recent forms of the Chemistry Achievement Test have been about 32 scale-score points.

The March sample of respondents seems to be very typical of the total candidate population as far as chemistry achievement is concerned. The respondents from the other administrations were a little more able on the test than the total populations although the differences are no more than two-thirds of the standard error of measurement for recent test forms. It appears that the respondents represent the total Chemistry Achievement Test population.

II. Secondary School Courses Taken by the Respondents

The questionnaires provide information on the high school courses selected by the respondents. Increased understanding of the chemistry respondents may result from comparing the courses they select with the courses selected by respondents to the questionnaires sent to Biology and Physics Achievement Test candidates. Table II-1 gives the percentages of respondents to the Biology, Chemistry, and Physics Questionnaires who took the courses in seven areas.

TABLE II-1

Percentages of December-January Senior Respondents to Science Questionnaires Who Took Secondary School Courses* in Specified Academic Areas

Grade and Courses	Biology Respondents	Chemistry Respondents	Physics Respondents
Ninth			
English	98	99	99
Mathematics	98	99	99
Social Science	78	80	82
Foreign Language	82	85	80
Science	78	82	85
Art, Music	50	44	45
Practical Arts	28	28	33
Tenth			
English	98	99	100
Mathematics	95	99	99
Social Science	60	63	62
Foreign Language	88	91	88
Science	87	87	85
Art, Music	38	32	31
Practical Arts	19	18	25
Eleventh			
English	98	99	99
Mathematics	86	96	97
Social Science	89	86	86
Foreign Language	75	73	70
Science	84	95	85
Art, Music	32	27	25
Practical Arts	20	18	23
Twelfth			
English	98	98	99
Mathematics	62	90	96
Social Science	83	81	81
Foreign Language	49	43	40
Science	81	93	92
Art, Music	35	26	26
Practical Arts	31	23	29

*Some respondents took more than one course in certain areas during the same school year.

The data presented are for the first semester. Second-semester percentages are generally a little smaller. The nature of the differences is illustrated by the following information for tenth grade chemistry respondents with the first semester percentage listed first: English 99.36, 98.88; mathematics 98.57, 97.61; social studies 63.16, 61.88; foreign languages 90.90, 90.11; science 87.40, 86.44; art, music 32.21, 31.26; practical arts 18.50, 18.35.

The most striking difference among the courses of the three groups of respondents is that the biology students took fewer mathematics courses. The biology respondents not only took fewer mathematics courses each year through secondary school, but also each year the difference between the percentage of biology respondents taking mathematics and the percentages of chemistry and physics respondents taking mathematics grew greater. Somewhat more of the biology respondents took art and/or music than did the chemistry and physics respondents. The sophomore year is interesting in that for each of the groups of science respondents, a larger percentage took foreign language and a smaller percentage took social science than during any of the other years. More than eighty per cent of the chemistry and physics respondents took science each of the four school years. For the biology respondents, seventy-eight per cent took freshman science; for the other years the percentages were above eighty per cent.

Table II-2 gives the same sort of data for the science respondents from the March and the May administrations of the College Board Science Tests.

TABLE II-2

Percentages of March Senior and May Junior Respondents to Science Questionnaires Who Took Secondary School Courses* in Specified Academic Areas

Grade and Courses	Biology Respondents	Chemistry Respondents	Physics Respondents
March Seniors			
Ninth			
English	97	100	99
Mathematics	96	99	98
Social Science	76	62	80
Foreign Language	75	75	79
Science	77	75	72
Art, Music	48	47	36
Practical Arts	29	25	30

TABLE II-2-Continued

Grade and Courses	Biology Respondents	Chemistry Respondents	Physics Respondents
Tenth			
English	96	99	98
Mathematics	92	98	99
Social Science	62	63	61
Foreign Language	81	81	87
Science	80	72	80
Art, Music	39	36	26
Practical Arts	22	17	22
Eleventh			
English	96	100	97
Mathematics	80	94	97
Social Science	89	89	81
Foreign Language	62	58	67
Science	77	86	91
Art, Music	36	29	21
Practical Arts	21	22	22
Twelfth			
English	96	99	97
Mathematics	59	84	93
Social Science	83	83	78
Foreign Language	46	38	41
Science	77	92	95
Art, Music	35	26	22
Practical Arts	33	30	26
May Juniors			
Ninth			
English	99	99	99
Mathematics	98	98	98
Social Science	83	81	80
Foreign Language	90	87	89
Science	74	79	88
Art, Music	52	41	44
Practical Arts	23	21	25
Tenth			
English	99	98	99
Mathematics	97	96	98
Social Science	61	57	66
Foreign Language	96	92	92
Science	72	82	89
Art, Music	36	28	30
Practical Arts	16	18	19

TABLE II-2-Continued

Grade and Courses	Biology Respondents	Chemistry Respondents	Physics Respondents
Eleventh			
English	99	99	99
Mathematics	92	93	98
Social Science	77	77	76
Foreign Language	86	80	73
Science	90	98	98
Art, Music	31	23	25
Practical Arts	14	15	13

*See footnote to Table II-1 .

A comparison of Table II-2 with Table II-1 shows that the March biology and chemistry respondents had fewer science courses than the respondents from December-January. The May biology respondents also appear to have had somewhat fewer science courses than the December-January biology group although the former had had about as much mathematics as the chemistry or the physics respondents and considerably more than the March biology respondents. Other generalizations about the courses taken by the December-January science respondents are true of the March and May respondents. Since the May respondents had not yet begun their senior year, information on the courses that they took is not available.

In general, the pattern of courses selected by each of the groups of science questionnaire respondents is the same.

Probably many of the differences among December, March, and May respondents to the Chemistry Questionnaire are due to differences in the percentages of girls, Midwesterners, and Roman Catholic school students in the samples.

Tables II-3, II-4, and II-5 explore this possibility of explaining the differences among the courses selected by these several classes of respondents.

Table II-3 gives information on differences in the courses taken by girl and boy respondents who completed the Chemistry Questionnaire.

TABLE II-3

Percentages of Boys and Girls Among the December-January Chemistry Questionnaire Respondents Who Took Secondary School Courses* in Specified Academic Areas

Grade and Courses	Boys	Girls
Ninth		
English	100	97
Mathematics	100	99
Social Science	81	74
Foreign Language	85	85
Science	82	83
Art, Music	42	55
Practical Arts	28	30
Tenth		
English	99	99
Mathematics	99	97
Social Science	64	58
Foreign Language	91	90
Science	89	80
Art, Music	30	43
Practical Arts	18	21
Eleventh		
English	99	97
Mathematics	98	90
Social Science	85	91
Foreign Language	72	77
Science	97	88
Art, Music	24	37
Practical Arts	19	12
Twelfth		
English	98	97
Mathematics	93	77
Social Science	80	82
Foreign Language	42	48
Science	95	86
Art, Music	25	31
Practical Arts	21	32

*See footnote to Table II-1.

Smaller percentages of the girls than boys took mathematics and science, and equal or larger percentages of the girls took foreign languages and art and/or music.

The courses taken by the December-January respondents from different types of secondary schools are shown in Table II-4.

TABLE II-4

Percentages of December-January Senior Respondents to the Chemistry Questionnaire Who Took Secondary School Courses* in Specified Academic Areas by Type of Secondary School

Grade and Courses	Public Schools	Roman Catholic Schools	Other Schools
Ninth			
English	100	99	100
Mathematics	99	99	100
Social Science	78	90	83
Foreign Language	82	97	92
Science	87	58	79
Art, Music	46	38	33
Practical Arts	33	12	0
Tenth			
English	99	99	100
Mathematics	98	99	100
Social Science	64	60	54
Foreign Language	90	97	92
Science	89	77	92
Art, Music	34	26	21
Practical Arts	21	9	12
Eleventh			
English	99	97	96
Mathematics	96	97	96
Social Science	88	82	67
Foreign Language	70	83	79
Science	95	98	83
Art, Music	27	25	29
Practical Arts	20	8	8
Twelfth			
English	98	97	100
Mathematics	90	93	88
Social Science	82	76	79
Foreign Language	40	58	42
Science	93	92	96
Art, Music	26	24	38
Practical Arts	24	25	0

* See footnote to Table II-1.

Conclusions supported by the data of Table II-4 include the following.

Respondents from public schools took more science, more art and/or music, and more practical arts during the freshman year than did students from Roman Catholic schools and the other schools. Freshman students from Roman Catholic schools and the other schools. Freshman students from Roman Catholic schools took less science replacing it by more social science and more foreign language. Public school respondents took more science as sophomores than did Roman Catholic school respondents, but they took less foreign language. During the sophomore year, respondents from the other schools were high in science but low in social science. During the junior year, students from the other schools were low in taking both science and social science, but otherwise the courses taken by respondents were about the same during the last two years regardless of the type of school. Throughout the secondary school years, public school respondents took more practical arts courses than students from the other schools and, except for the senior year, than the students from Roman Catholic schools.

Data on courses taken by respondents from the different regions of the country are presented in Table II-5.

TABLE II-5

Percentages of December-January Senior Respondents to the Chemistry Questionnaire Who Took Secondary School Courses* in Specified Academic Areas by Region of the Country

Grade and Courses	Northeast	South	Midwest	West
Ninth				
English	99	99	100	99
Mathematics	100	99	100	98
Social Science	91	70	61	74
Foreign Language	92	71	78	82
Science	89	91	71	68
Art, Music	50	37	43	31
Practical Arts	29	23	26	33
Tenth				
English	99	100	100	99
Mathematics	99	97	97	100
Social Science	70	60	53	55
Foreign Language	93	81	91	90
Science	93	95	78	82
Art, Music	33	33	40	20
Practical Arts	18	10	20	23
Eleventh				
English	99	99	99	98
Mathematics	97	97	96	94
Social Science	86	87	88	83
Foreign Language	85	69	49	67
Science	95	96	94	98
Art, Music	28	24	32	18
Practical Arts	18	21	16	15
Twelfth				
English	98	100	98	97
Mathematics	91	89	88	90
Social Science	81	76	84	79
Foreign Language	49	36	30	46
Science	94	89	94	94
Art, Music	26	26	33	22
Practical Arts	24	29	23	15

* See footnote to Table II-1.

Respondents from the Northeast appear to take more courses as freshmen than do their counterparts from the other regions. The Northeasterners are highest in percentages taking social studies, foreign languages, a l art and/or music. Their percentages taking English, mathematics, and science are as high or nearly as high as any area. Respondents from the Midwest and the West had relatively low percentages taking science during both the freshman and sophomore years. Percentages of the respondents taking courses in the academic areas studied are quite similar across the country during the junior and senior years.

Further information about the emphasis on various secondary school courses by the respondents is obtained by looking at the percentages of these students who take more than one course in a particular academic area in a single year. Table II-6 gives such information.

TABLE II-6

Percentages of December-January Senior Respondents to the Chemistry Questionnaire Who Took More Than One Course Concurrently in Certain Academic Areas by Type of School

Grade and Courses	Public Schools	Roman Catholic Schools	Other Schools
Ninth			
English	3.8	7.8	4.2
Mathematics	0.8	2.0	0.0
Social Science	0.2	1.0	0.0
Foreign Language	1.6	3.0	8.3
Science	1.0	2.0	0.0
Art, Music	12.0	5.9	0.0
Practical Arts	3.2	0.0	0.0
Tenth			
English	5.6	5.9	4.2
Mathematics	1.2	0.0	8.3
Social Science	0.4	1.0	4.2
Foreign Language	6.8	33.3	8.3
Science	1.6	1.0	4.2
Art, Music	5.6	2.0	4.2
Practical Arts	2.6	0.0	0.0
Eleventh			
English	7.4	3.9	8.3
Mathematics	1.8	1.0	8.3
Social Science	1.4	1.0	4.2
Foreign Language	2.6	11.8	4.2
Science	4.6	2.9	8.3
Art, Music	4.6	0.0	4.2
Practical Arts	0.4	1.0	0.0
Twelfth			
English	11.8	5.9	8.3
Mathematics	6.4	3.9	4.2
Social Science	7.0	4.9	8.3
Foreign Language	1.0	4.9	4.2
Science	17.8	8.8	16.7
Art, Music	4.8	2.0	4.2
Practical Arts	3.2	1.0	0.0

In all three types of schools, the percentages of the respondents who took more than one science course during the same semester rose from freshman to senior year, reaching a sixth or more of the students in both public and other schools during the senior year. Other areas in which the percentages of respondents taking more than one course in one semester exceeded ten per cent were foreign languages in the sophomore and junior years in Roman Catholic schools, art and/or music with public school freshmen, and English with public school seniors.

Table II-7 puts into one table the percentages of respondents to the chemistry questionnaire who took courses in certain academic areas arranged by the month during which the respondents took the Chemistry Achievement Test.

TABLE II-7

Percentages of Chemistry Questionnaire Respondents Who Took Courses in Certain Academic Areas by the Month in Which the Chemistry Achievement Test Was Taken

Grade and Courses	December-January Seniors	March Seniors	May Juniors
Ninth			
English	99	100	99
Mathematics	99	99	98
Social Science	80	62	81
Foreign Language	85	75	87
Science	82	75	79
Art, Music	44	47	42
Practical Arts	28	24	21
Tenth			
English	100	99	98
Mathematics	99	98	96
Social Science	63	63	57
Foreign Language	91	81	92
Science	87	72	82
Art, Music	32	36	28
Practical Arts	18	17	18
Eleventh			
English	99	100	99
Mathematics	96	94	93
Social Science	86	89	77
Foreign Language	73	58	80
Science	95	86	98
Art, Music	27	29	23
Practical Arts	18	22	15
Twelfth			
English	98	99	
Mathematics	90	84	
Social Science	81	83	
Foreign Language	43	38	
Science	93	92	
Art, Music	26	26	
Practical Arts	23	30	

The greatest differences among these three groups of respondents are noted in the percentages for the freshmen year: March respondents took less social studies, foreign language, and a little less science than the respondents from other administrations. The March respondents also took less foreign language and science during the sophomore year. Probably these differences can be accounted for by the differences in the types of schools and the regions of the country from which respondents from the different administrations came.

Probably more interesting than the percentages of respondents who took science during a certain high school year are the courses which they took. Table II-8 gives information of this sort.

TABLE II-8

Percentages of Chemistry Questionnaire Respondents Who Took Certain Science Courses by Year in Secondary School and by the Month in Which the Chemistry Achievement Test Was Taken

Grade and Courses	December-January Seniors	March Seniors	May Juniors
Ninth			
General Science	49	37	45
Biology, 1st h.s. course	18	27	14
Earth Science	8	4	14
Tenth			
Biology, 1st h.s. course	62	52	63
Biology, college level	4	3	5
Biology, 2nd h.s. course	3	4	3
Chemistry, 1st h.s. course	12	8	3
Physics, 1st h.s. course	2	1	2
Earth Science	.8	.8	.9
General Science	.9	2	.9
Eleventh			
Chemistry, 1st h.s. course	68	46	81
Chemistry, college level	5	5	10
Chemistry, 2nd h.s. course	3	3	4
Physics, 1st h.s. course	14	23	2
Physics, 2nd h.s. course	.4	2	0
Biology, 1st h.s. course	1	3	.6
Biology, 2nd h.s. course	1	2	.3
Other	2	2	.9
Science Seminar	.4	.2	.3
Twelfth			
Physics, 1st h.s. course	61	37	
Physics, college level	5	5	
Physics, 2nd h.s. course	3	3	
Chemistry, 1st h.s. course	7	30	
Chemistry, college level	11	9	
Chemistry, 2nd h.s. course	7	7	
Biology, 1st h.s. course	.7	0	
Biology, college level	1	.2	
Biology, 2nd h.s. course	2	3	
Other	4	3	
Science Seminar	2	.3	

The table indicates that there was a widely used sequence of science courses: general science for freshmen, biology for sophomores, chemistry for juniors, and physics for seniors. In the case of the December-January group, the appropriate course in this sequence was taken by more than sixty per cent of the respondents during each of the last three secondary school years. Since the freshman year is the year when these students were least likely to take science, it is not surprising to find that the enrollment in general science included only half of this group. It appears that there was a second most popular sequence of courses: biology in the freshman year, chemistry in the sophomore year, and physics in the junior year. No doubt many of these students then took a college-level science course or a second-year science course during the senior year. The responses of the senior respondents indicate that earth sciences had not had much influence on the secondary school graduate of 1966. The May junior respondents show a higher percentage of earth science students. These May students were probably somewhat less typical of the total secondary school class than were the students in the other two groups of respondents, and so the higher percentage of earth science students may mean that this course was particularly likely to be offered to better students, or it may mean that the acceptance of earth science had markedly increased when the class of 1967 was in its freshman year.

Since all of the respondents took the College Board Chemistry Achievement Test, the percentages of these students who took chemistry in secondary school is higher than are the percentages for the other sciences. It would be interesting to know the percentages of the respondents who took biology and physics, but the available data do not provide this information. As subsequent tables show, the second year high school science courses and the college level science courses were taken as a first science course in a particular subject by some but not all students, and so some of the registrants in such courses should be counted in determining total percentages of respondents who took a subject, but others should not be. The tables do show that at least eighty per cent of the chemistry questionnaire respondents took biology and more than two thirds took physics. The biology percentage is similar to that for the total secondary school population, but only about twenty per cent of all secondary school students take physics. Clearly the chemistry questionnaire respondents were a superior group as far as science education is concerned.

Differences in regard to type of school and region of the country between the December-January seniors and the March seniors have been mentioned before. Whether these differences account for all of the differences in science courses selected when one compares December-January and March respondents or whether there are some other differences is hard to decide. Fewer of the March respondents took general science and more of them took biology as freshmen than did the December-January group. This change then influenced the selection of science courses through the next three secondary school years for these people.

Tables II-9 and II-10 give for the December-January seniors the science course selections by type of school and by region of the country.

TABLE II-9

Percentages of December-January Senior Respondents to the Chemistry Questionnaire Who Took Certain Science Courses by Year in Secondary School and by Type of Secondary School

Grade and Courses	Public Schools	Roman Catholic Schools	Other Schools
Ninth			
General Science	51	36	50
Biology, 1st h.s. course	20	11	18
Earth Science	9	5	7
Tenth			
Biology, 1st h.s. course	63	62	50
Biology, college level	3	6	2
Biology, 2nd h.s. course	3	7	2
Chemistry, 1st h.s. course	14	2	12
Physics, 1st h.s. course	2		7
Earth Science	1	.5	
General Science	.8		
Eleventh			
Chemistry, 1st h.s. course	68	75	48
Chemistry, college level	5	7	7
Chemistry, 2nd h.s. course	3	5	4
Physics, 1st h.s. course	15	6	14
Physics, 2nd h.s. course	.5		2
Biology, 1st h.s. course	.9	1	4
Biology, 2nd h.s. course	1		2
Science Seminar	.2	2	
Twelfth			
Physics, 1st h.s. course	62	64	38
Physics, college level	5	8	5
Physics, 2nd h.s. course	3	5	4
Chemistry, 1st h.s. course	6	6	29
Chemistry, college level	12	6	16
Chemistry, 2nd h.s. course	8	.9	5
Biology, 1st h.s. course	.4	2	
Biology, college level	1	1	
Biology, 2nd h.s. course	3	1	2
Science Seminar	2	2	4

As noted previously, respondents from Roman Catholic secondary schools took fewer science courses as secondary school freshmen. Table II-9 indicates that this difference affected the percentages of respondents who took each of the three freshman science courses with appreciable enrollments. In the sophomore year more Roman Catholic school respondents than public school respondents took biology, but only a fraction as many took chemistry. During the junior year more of the Roman Catholic school respondents took chemistry and fewer took physics. Differences in senior year science between respondents from these two types of schools are not striking.

As freshmen, respondents from the other schools were quite similar to public school students in their selections of science courses. During the sophomore year fewer of the other school respondents took biology than did students in either of the other types of schools. This reduction seems not to have been made up by biology enrollments in other years.

The percentage of other school sophomore respondents in chemistry is similar to that for public school sophomores. Fewer of the other school juniors took chemistry than did students from the other types of schools, but this reduction is compensated for by the percentage of those who took first year secondary school chemistry as seniors.

Table II-9 makes clear that the usual pattern of science courses was less strong in the other schools than in public or Roman Catholic schools.

TABLE II-10

Percentages of December-January Senior Respondents to the Chemistry Questionnaire Who Took Certain Science Courses by Year in Secondary School and by Region of the Country

Grade and Courses	Northeast	South	Midwest	West
Ninth				
General Science	55	53	34	47
Biology, 1st h.s. course	15	19	30	14
Earth Science	13	4	2	1
Tenth				
Biology, 1st h.s. course	67	64	53	55
Biology, college level	4	1	3	5
Biology, 2nd h.s. course	3	4	3	4
Chemistry, 1st h.s. course	12	12	13	10
Physics, 1st h.s. course	2	2	2	.5
Earth Science	.8		2	
General Science	1		1	1
Eleventh				
Chemistry, 1st h.s. course	64	73	73	74
Chemistry, college level	6	2	6	5
Chemistry, 2nd h.s. course	3	6	2	3
Physics, 1st h.s. course	16	9	11	11
Physics, 2nd h.s. course	.7		.3	
Biology, 1st h.s. course	1	.8	1	2
Biology, 2nd h.s. course	1	.8	1	.5
Science Seminar	.1		2	
Twelfth				
Physics, 1st h.s. course	57	64	66	68
Physics, college level	6	3	5	6
Physics, 2nd h.s. course	4	2	2	3
Chemistry, 1st h.s. course	10	7	4	3
Chemistry, college level	11	7	12	10
Chemistry, 2nd h.s. course	7	10	4	8
Biology, 1st h.s. course	.7	1	.3	.5
Biology, college level	1	.7	2	
Biology, 2nd h.s. course	2	2	3	4
Science Seminar	1		3	1

Table II-10 shows that respondents from different regions of the country did differ in some ways in their science course selections. The Northeasterners and Southerners were similar in their freshman and sophomore science except that earth science drew more than three times as great a percentage of respondents in the Northeast. The course selections of Westerners for the freshman and sopho[illegible] years were similar to those of the Southern respondents except that most of the percentages were a little smaller because freshman and sophomore science was less popular in the West than elsewhere. The science course selection in the Midwest during the first two secondary school years was most different from those in the other regions of the country. General science was only a little more popular than first-course biology and each was taken by about one third of the Midwest respondents. As a result, the percentage of the Midwesterners taking biology as sophomores is a little lower than elsewhere and the percentage of sophomores taking first-course chemistry is a little higher.

Registrations in science courses for juniors and seniors appear to differ less across the country than do the course selections for the first year in secondary school. In the Northeast somewhat fewer juniors among the respondents registered for first year chemistry, somewhat more registered for first year physics; somewhat fewer seniors registered for first-course physics, somewhat more registered for first-course chemistry.

III. Length of the Chemistry Classes of the Respondents

Information provided by the respondents on the amount of time spent each week in chemistry classes is summarized in Tables III-1 to III-6.

Table III-1 shows the number of single periods each week that the chemistry class met. Students were specifically told to count as two single periods any double periods in their chemistry schedule per week.

TABLE III-1

For Chemistry Questionnaire Respondents the Number of Single Periods per Week That Chemistry Classes Met by the Month in Which the Chemistry Achievement Test Was Taken

	December-January Seniors	March Seniors	May Juniors
	%	%	%
Three or Fewer	.6	2	.9
Four	2	2	1
Five	47	61	28
Six	23	13	32
Seven	19	13	29
Eight	3	3	2
Nine	.2	0	.9
Ten	3	5	1
Eleven or More	.7	0	0

Most seniors had five single periods each week for chemistry classes. The juniors reported that five, six, and seven periods a week for chemistry classes were about equally common.

Table III-2 gives the number of single periods a week for chemistry for different types of schools. The data are based on the replies of December-January seniors only.

TABLE III-2

For December-January Senior Respondents to the Chemistry Questionnaire the Number of Single Periods per Week That Chemistry Classes Met by Type of Secondary School

	Public Schools	Roman Catholic Schools	Other Schools
	%	%	%
Three or Fewer	.5	1.4	0
Four	2	2	2
Five	50	39	32
Six	21	30	25
Seven	18	20	25
Eight	3	3	5
Nine	.1	0	1
Ten	3	1	0
Eleven or More	.7	.5	2

On the average, students in Roman Catholic schools and in the other schools spent more periods a week in chemistry classes than did students in public schools. Half of the public school seniors spent five periods a week in chemistry class.

Table III-3 shows for December-January senior respondents the number of class periods for chemistry in four regions of the country.

TABLE III-3

For December-January Senior Respondents to the Chemistry Questionnaire the Number of Single Periods per Week That Chemistry Classes Met by Region of the Country

	Northeast	South	Midwest	West
	%	%	%	%
Three or Fewer	.5	.7	1	.5
Four	1	1	3	2
Five	25	80	63	83
Six	40	6	3	3
Seven	25	4	19	4
Eight	3	.7	5	.5
Nine	0	.7	0	.5
Ten	3	3	3	2
Eleven or More	.4	2	.6	.5

For this sample, at least, students in the Northeast spent more periods a week in chemistry classes than did students from other parts of the country. In the South and the West, four fifths of the students spent five periods a week in chemistry class.

A class period is not a constant number of minutes across the country, however. Therefore, students were asked how long their class periods were. Table III-4 gives their responses in percentages.

TABLE III-4

Percentages of Chemistry Questionnaire Respondents with Single Chemistry Class Periods of Certain Lengths by the Month in Which the Chemistry Achievement Test Was Taken

	December-January Seniors	March Seniors	May Juniors
Less than 40 minutes	.8	1	2
40-49 minutes	50	30	61
50-59 minutes	41	61	27
60 minutes or more	5	6	4

More than ninety per cent of the classes were in the range from 40 minutes to 59 minutes. Differences among the groups are discussed after Table III-6.

In Table III-5 the responses of the December-January seniors on the length of an average class period shown are by the type of school the student attended.

TABLE III-5

Percentages of December-January Senior Respondents to the Chemistry Questionnaire with Single Chemistry Class Periods of Certain Lengths by Type of Secondary School

	Public Schools	Roman Catholic Schools	Other Schools
Less than 40 minutes	.7	2	0
40-49 minutes	46	63	55
50-59 minutes	44	26	36
60 minutes or more	5	5	2

The length of class period seems most nearly standardized in the Roman Catholic schools for which more than sixty per cent of the students report class periods from 40 to 49 minutes in length. Periods 60 minutes long or longer were not popular in any type of school.

Table III-6 shows the length of class period for December-January seniors from the four regions of the country.

TABLE III-6

Percentages of December-January Senior Respondents to the Chemistry Questionnaire Who Have Single Chemistry Class Periods of Certain Lengths by Region of the Country

	Northeast	South	Midwest	West
Less than 40 minutes	1	0	.6	.5
40-49 minutes	73	10	29	23
50-59 minutes	20	80	58	64
60 minutes or more	2	7	8	7

For the Northeast, 40- to 49-minute periods were reported by nearly three fourths of the students. In the other regions of the country periods between 50 and 59 minutes were most popular, and in the South periods of this length were reported by eighty per cent of the students. If one studies both Table III-3 and Table III-6, he observes that the students in the Northeast had both the most periods for chemistry each week and the fewest minutes in each of these periods. The actual time per week spent in chemistry class did not differ across the country as much as either of these tables alone suggests.

The reported differences between the number of chemistry classes each week and the lengths of these classes for December-January seniors and for March seniors (Tables III-1 and III-4) can largely be accounted for by differences in the make-up of the groups taking the test at these two times. For instance, the Northeast contributes a larger percentage of the candidates to the December-January sample than to the March sample. These Northeast candidates made the average period shorter and the number of periods longer for the December-January candidates than they were for the March group.

A particularly significant matter related to science instruction is the amount of time spent in the laboratory each week. Table III-7 shows the amount of laboratory time for chemistry per week as reported by students from the three test administrations studied.

TABLE III-7

Percentages of Chemistry Questionnaire Respondents with Certain Amounts of Chemistry Laboratory Time per Week

Time per Week	December-January Seniors	March Seniors	May Juniors
None	1	.8	1
30 minutes or less	8	14	8
About 45 minutes	18	15	16
About 1 hour	18	21	16
About 1½ hours	29	22	32
About 2 hours	13	16	12
More than 2 hours	8	8	10

Table III-8 shows the weekly laboratory time for chemistry as reported by December-January seniors from the different types of school.

TABLE III-8

Percentages of December-January Senior Respondents to the Chemistry Questionnaire Who Had Certain Amounts of Chemistry Laboratory Time per Week by Type of Secondary School

Time per Week	Public Schools	Roman Catholic Schools	Other Schools
None	1	2	0
30 minutes or less	9	8	7
About 45 minutes	18	22	12
About 1 hour	19	14	20
About 1½ hours	28	37	23
About 2 hours	14	8	12
More than 2 hours	8	6	16

The distribution of students into laboratory times of different lengths is clearly related to the lengths of periods in the type of school they attended. (Table III-5). This is particularly obvious for the Roman

Catholic school students. Long laboratory periods (more than 2 hours) were considerably more common for students from nonpublic, non-Catholic schools.

Table III-9 shows the length of time per week devoted to chemistry laboratory as reported by December-January seniors from the four regions of the country.

TABLE III-9

Percentages of December-January Senior Respondents to the Chemistry Questionnaire Who Had Certain Amounts of Chemistry Laboratory Time per Week by Region of the Country

Time per Week	Northeast	South	Midwest	West
None	1	4	0.6	2
30 minutes or less	6	20	8	11
About 45 minutes	20	14	17	17
About 1 hour	13	24	23	26
About 1½ hours	40	14	19	19
About 2 hours	10	11	19	13
More than 2 hours	7	7	10	9

For these students at least, more time was devoted to chemistry laboratory in schools in the Northeast than in other regions of the country, and students in the South had had the least time in the chemistry laboratory.

IV. Textbooks

Two facts made a survey of secondary-school chemistry texts seem worthwhile.

1. Each of the NSF-supported chemistry courses is based on chemistry text. The number of students who report that they have used these texts gives a measure of the degree of acceptance of these courses.
2. In secondary school chemistry as in few courses at any level, a single text has been dominant for some years. The degree to

which this dominance has been continued gives an important insight into secondary school chemistry education.

Table IV-1 summarizes information on primary textbooks for respondents from the three administrations studied and for the first secondary school chemistry course.

TABLE IV-1

Percentages of Chemistry Questionnaire Respondents Who Used as Their Primary Textbook in Their First Secondary School Course the Most Widely Used Texts

		December-January Seniors	March Seniors	May Seniors
Dull and others or Metcalfe and Others	Modern Chemistry	56	57	44
Chemical Education Material Study	Chemistry: An Experimental Science	16	17	18
Baker and others	Chemistry and You	5	4	4
Brownlee and others	Elements of Chemistry	3	2	4
Chemical Bond Approach Project	Chemical Systems	3	2	2
Garrett and others	Chemistry: A First Course in Modern Chemistry	3	6	2

In all, respondents listed more than fifty other texts, problem books, laboratory manuals, and review books as being primary texts in their first secondary school chemistry courses.

The smaller percentage of students in the May administration listing Modern Chemistry as their primary text compared to the percentages at the other administrations suggested a more detailed examination of the information on texts. Table IV-2 gives information on primary textbooks for the first secondary school course for respondents by type of school and by region of the country.

TABLE IV-2

Percentages of Chemistry Questionnaire Respondents Who Use as Their Primary Textbook in Their First Secondary School Chemistry Course Certain Widely Used Texts by Test Administration, by Type of School, and by Region of the Country

	Public Schools	Roman Catholic Schools	Other Schools	Northeast	South	Midwest	West
December-January Seniors							
Modern Chemistry	56	58	50	60	59	52	43
Chemical Systems	3	2	4	2	3	4	4
Chemistry: An Experimental Science	15	20	14	8	18	23	31
May Juniors							
Modern Chemistry	50	38	26	47	33	46	28
Chemical Systems	3	3	4	3	3	3	2
Chemistry: An Experimental Science	15	27	24	14	26	29	34

The data in Table IV-2 indicate considerable differences in the popularity of Modern Chemistry, the most widely used text, both by type of school and by region of the country. It is least used in the other schools and in the West. Compared to the use reported by the December-January seniors, the May juniors show smaller percentages for Modern Chemistry in all types of schools and in all regions of the country. The shift from Modern Chemistry was, in general, to the CHEMS course and its textbook. Compared to December-January, the CHEMS text was more popular in May in the Roman Catholic schools and in the other schools and in all four regions of the country, but only in the Midwest does the increased popularity of the CHEMS book correspond closely to the drop in the use of Modern Chemistry. The data show that, at least for the schools represented by the questionnaire respondents, a greater variety of textbooks was being used for the May juniors than for the December-January seniors.

V. Students in the New Chemistry Courses

One of the reasons for recent interest in a candidate survey of students who have taken a College Board Chemistry Achievement Test is a desire to know more about the students who have taken one of the newly developed chemistry courses: the Chemical Bond Approach Project (CBA) and the Chemical Education Material Study (CHEMS).

Table V-1 gives the numbers and the percentages of CBA and CHEMS students in the respondents from the administrations of the College Board Chemistry Achievement Test that were studied. When students take the test, they are asked to provide a small amount of information about their course on the answer sheet by answering a question about the type of course they have taken. The question is answered before the start of the test itself. (A copy of the page on which this information is requested is Appendix III.) Data on the number of CBA and CHEMS students for two 1966 administrations from the answer sheets is also included in Table V-1.

TABLE V-1

Number and Percentages of CBA and CHEMS Students among the Chemistry Questionnaire Respondents and in the CEEB Achievement Test Population for Certain Administrations

	Chemistry Questionnaire Respondents			Chemistry Achievement Test Candidates*	
	December-January 1965-1966	March 1966	May 1966	January 1966	May 1966
CBA	33 2.5%	8 2.1%	19 2.8%	527 4.2%	1121 4.3%
CHEMS	185 13.9%	58 15.0%	120 18.6%	2295 18.5%	6537 25.1%

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*Data available for January and May only.

The percentages of CBA and CHEMS students among the respondents and in the Chemistry Achievement Test population are not as similar as might have been expected. Several factors may be relevant in the explanation. For the questionnaire respondents, students were classified as in CBA or CHEMS classes if they listed the appropriate text in the part of the questionnaire calling for text identification. It seems unlikely, but perhaps some CBA or CHEMS students do not use the appropriate text. For the questionnaire, students were urged to consult teachers about the answers to questions for which the students were not sure of the answers. Students taking the Chemistry Achievement Test are unlikely to have a teacher available during the few minutes when the information about the course is entered on the answer sheet. It is unlikely, however, that the number of students who err in marking the answer sheets is as high as would be required if the questionnaire data are correct and the answer sheet data are not. The data from the test administrations are for the total candidate population rather than for a single secondary school class as are the questionnaire respondents. Because the test administration populations are largely from a single class (Table I-1), this factor also seems unlikely to be the explanation for the differences. Perhaps students from the new courses were particularly unwilling to complete and return the questionnaires.

Since the numbers of CBA and CHEMS respondents at the administrations is not large, their responses have been combined to provide somewhat larger samples for the tables in this section of the report. Because of the small sample sizes, the data from the different administrations have not been weighted to reflect the total candidate population. The results presented are merely a tabulation of the combined data. The small numbers of respondents from the CBA course make the data about these respondents and their course particularly subject to uncertainty.

Tables V-2, V-3, and V-4 permit comparisons of new course students with other respondents on a few characteristics. Table V-2 gives information on the sexes of the CBA and CHEMS respondents compared to the total Chemistry Achievement Test population and to the total group of respondents.

TABLE V-2

1965-1966 Chemistry Achievement Test Population, Questionnaire Respondents, CBA Respondents, and CHEMS Respondents by Sex

	Boys		Girls	
	Numbers	Percentages	Numbers	Percentages
1965-66 Chemistry Achievement Test Candidates	52,457	77.6	15,266	22.4
Total Questionnaire Respondents	1,868	78.0	527	22.0
CBA Respondents	51	85.0	9	15.0
CHEMS Respondents	279	77.0	74	23.0

The low percentage of girls in the CBA group may be due to the fact that the CBA sample is small and may not be representative.

Information on Scholastic Aptitude Test scores and on College Board Chemistry Achievement Test scores from respondents from the CBA and CHEMS classes and for the total group of respondents is given in Table V-3.

TABLE V-3

SAT Scores and CEEB Chemistry Achievement Test Scores of CBA and CHEMS Respondents and for the Total Group of Questionnaire Respondents

	Scholastic Aptitude Test		Chemistry
	Verbal	Mathematical	Achievement Test
CBA Respondents	563	624	552
CHEMS Respondents	566	626	562
All Respondents	545	604	558

Respondents from the two new courses were quite similar in their performances on the ability measures. Both groups were better than the total group of questionnaire respondents by about two thirds of a standard error of measurement. Comparatively they did not do quite so well on the Chemistry Achievement Test as might have been expected. The report, Curricular Appropriateness of the Science Tests, dated January, 1967, and available from the College Entrance Examination Board, Box 592, Princeton, New Jersey, gives the results of more careful studies of the abilities of students of these new courses and of their performances on the test. These studies have led to the conclusion that recent forms of the test are a fair measure of chemistry achievement for CBA and CHEMS students and for students of the most widely used chemistry text.

Table V-4 provides information on the sequences of science courses taken in secondary school by students in the new courses and by the total group of December-January respondents to the questionnaire.

TABLE V-4

Percentages of Respondents in New Courses and of All December-January Respondents Who Took Certain Secondary School Science Courses

Grade and Courses	December-January Respondents	CBA Respondents	CHEMS Respondents
Ninth			
General Science	49	36	38
Biology, 1st h.s. course	18	17	14
Earth Science	8	7	7
Tenth			
Biology, 1st h.s. course	62	54	59
Biology, college level	4	7	5
Biology, 2nd h.s. course	3	3	4
Chemistry, 1st h.s. course	12	7	5
Physics, 1st h.s. course	2	5	2
Earth Science	.8	0	2
General Science	.9	2	1
Eleventh			
Chemistry, 1st h.s. course	68	61	66
Chemistry, college level	5	14	11
Chemistry, 2nd h.s. course	3	3	3
Physics, 1st h.s. course	14	8	8
Physics, 2nd h.s. course	.4	0	0
Biology, 1st h.s. course	1	2	1
Biology, 2nd h.s. course	1	2	1
Science Seminar	.4	2	1
Twelfth			
Physics, 1st h.s. course	61	46	57
Physics, college level	5	15	7
Physics, 2nd h.s. course	3	8	4
Chemistry, 1st h.s. course	7	15	8
Chemistry, college level	11	10	7
Chemistry, 2nd h.s. course	7	10	7
Biology, 1st h.s. course	.7	0	1
Biology, college level	1	0	.4
Biology, 2nd h.s. course	2	0	4
Science Seminar	2		1

Students in the new courses appear to have taken somewhat less science during the freshman year than did the total group of December-January respondents. The reduction is due largely to fewer students in the new courses who took general science. Somewhat more of these students took the second-year courses and college-level courses in each of the three sciences, biology, chemistry, and physics, and correspondingly fewer of them took the first-year secondary school courses.

VI. Topics Studied

The questionnaire provided an opportunity to sample how widely a list of content topics is presented in secondary school chemistry classes. The Committee of Examiners for the College Board Chemistry Achievement Test contributed entries for the list. Some of these are topics about which they expressed interest. Other topics were added to make sure that all students would find some topics which they had studied. Some topics were included because there was a belief that they were topics that would serve to define one or another of the widely taught courses. The list was not designed to be definitive or exhaustive.

To provide further information about the frequency of presentation of the topics, a single-sheet questionnaire was sent to selected secondary school teachers. There were sixteen CBA teachers, twenty-six CHEMS teachers, and nineteen teachers who were using one of the editions of Modern Chemistry. About half of the teachers from each of the three groups were from New Jersey, and the others were from the Chicago area.

Table VI-1 contains the percentages of students of the three groups who were "certain that you had studied the topic in one or more of your chemistry courses" or that "you had learned about the topic both in your chemistry courses and elsewhere, such as in other courses or through independent study." The percentages of teachers who presented the topic in their classes are also included in the table. The students included in the CBA and CHEMS samples were all the students from these courses for whom replies were available regardless of the test administration from which the students were selected. The sample of students labeled conventional are all December-January respondents who had not taken a college-level or second-year chemistry course and who had not used the CBA or CHEMS text as their primary text.

TABLE VI-1

Percentages of Students Certain that the Listed Topics Have been Studied in Their Chemistry Courses and of Teachers Who Presented the Topics by Type of Secondary School Chemistry Course

	Conventional		CBA		CHEMS	
	Teachers	Students	Teachers	Students	Teachers	Students
Kinetics						
Activation energy	74	53	100	49	100	98
Reaction rate(reaction rate constant)	63	41	56	36	81	88
Organic						
Alkanes(methane hydrocarbons)	79	78	44	39	62	59
Fermentation	63	59	0	20	15	21
Free radical reactions	5	27	19	15	12	17
Hydrogenation	58	73	6	22	23	26
Cis and trans isomers	26	11	12	7	85	67
Solutions						
Brönsted acids(proton donors)	84	65	81	63	96	63
Conjugate acid-base pairs	42	45	81	51	73	56
Lewis acid(electron-pair receiver)	53	22	81	51	54	21
Normality	89	83	25	46	31	14
pH	95	86	88	64	92	93
Descriptive						
Allotropes	84	87	62	68	54	25
Anhydrides	95	91	25	39	50	42
Contact process (commercial preparation of H_2SO_4)	58	94	0	14	35	51
Destructive distillation	79	78	0	24	27	21
Ostwald process(commercial preparation of HNO_3)	47	56	0	8	15	22
Solvay process(commercial preparation of Na_2CO_3)	42	56	0	3	4	7
Water hardness	74	71	0	15	15	20
Equilibrium						
Buffers	37	37	12	20	31	18
Equilibrium constants	74	64	81	56	96	67
Hydrolysis	89	90	50	75	54	79
Le Chatelier's principle	89	56	88	36	92	94
Solubility product constant	53	40	50	37	96	89
Certain Physical Chemistry Topics						
Colloids	53	69	0	29	0	20
Periodic law	100	86	100	71	96	76
Phase diagram	26	13	44	36	38	27
Oxidation (electrode) potential	37	51	75	46	88	84
Oxidation-reduction	100	93	100	83	100	97

TABLE VI-1-Continued

	Conventional		CBA		CHEMS	
	Teachers	Students	Teachers	Students	Teachers	Students
Atomic Structure and Bonding						
Complex ions of transition elements	0	29	12	27	31	41
Covalent bonding	100	98	100	95	100	97
Coordinate covalent bonding	58	65	88	53	69	54
Dipole moments	37	39	88	53	81	64
Electron affinity	89	69	81	64	85	64
Electronegativity	89	82	94	76	85	59
Infrared spectrum	11	22	12	53	54	68
Ionic bonding	100	94	100	92	100	97
Ionization potential	63	68	94	68	96	81
K-shell	100	91	50	56	58	50
Lattice energy	11	29	69	61	35	42
Metallic bonding	48	62	100	75	100	76
Multiple proportions	89	68	44	37	81	62
π bonding	5	9	75	64	23	13
Quantum number	68	40	94	83	92	72
Radioactivity	58	66	19	32	81	50
Resonance	53	48	56	22	46	17
Thermodynamics						
Enthalpy changes	26	13	100	90	73	50
Free energy	16	33	81	44	27	28
Paramagnetism	21	21	69	46	27	21
Kinetic-Molecular Topics						
Graham's law	53	42	88	58	31	20
Ideal gas	84	73	100	92	88	84
Kinetic-molecular theory of gases	100	76	100	71	100	88

A different insight into the list of topics and the percentages of students and of teachers who consider the topic to have been taught is obtained from Tables VI-2, VI-3, and VI-4. These tables, one for each of the major types of course, give the topics that were most frequently selected by the teachers as having been studied. The appropriate percentages of teachers and students from the other types of courses are also entered for each of these courses for comparison. A study of these tables indicates the topics uniquely associated with each of the types of courses.

TABLE VI-2

Topics Most Frequently Selected by CBA Teachers as Having Been Studied

	CBA		CHEMS		Conventional	
	Teachers	Students	Teachers	Students	Teachers	Students
Activation energy	100	49	100	98	74	53
Covalent bonding	100	95	100	97	100	98
Electronegativity	94	76	85	59	89	82
Enthalpy changes (changes in the heat stored in a system)	100	90	73	50	26	13
Ideal gas	100	92	88	84	84	73
Ionic bonding	100	92	100	97	100	94
Ionization potential	94	68	96	81	63	68
Kinetic-molecular theory of gases	100	71	100	88	100	76
Metallic bonding(the forces holding metal atoms in the solid state)	100	75	100	76	42	62
Oxidation-reduction	100	83	100	97	100	93
Periodic law(many properties of the elements are periodic functions of their atomic numbers)	100	71	96	76	100	86
Quantum number	94	83	92	72	68	40

TABLE VI-3

Topics most Frequently Selected by CHEMS Teachers as Having Been Studied

	CHEMS		CBA		Conventional	
	Teachers	Students	Teachers	Students	Teachers	Students
Activation energy	100	98	100	49	74	53
Brönsted acids(proton donors)	96	63	81	63	84	65
Covalent bonding	100	97	100	95	100	98
Equilibrium constants	96	67	81	56	74	64
Ionic bonding	100	97	100	92	100	94
Ionization potential	96	81	94	68	63	68
Kinetic-molecular theory of gases	100	88	100	71	100	78
Le Chatelier's principle	92	94	88	36	89	56
Metallic bonding(the forces holding metal atoms in the solid state)	100	76	100	75	42	62
Oxidation-reduction	100	97	100	83	100	93
Periodic law(many properties of the elements are periodic functions of their atomic numbers)	96	76	100	71	100	86
pH	92	93	88	64	95	86
Quantum number	92	72	94	83	68	40
Solubility product constant	96	89	50	37	53	40

TABLE VI-4

Topics Most Frequently Selected by Other Teachers As Having Been Studied

	Conventional		CBA		CHEMS	
	Teachers	Students	Teachers	Students	Teachers	Students
Anhydrides	95	91	25	39	50	42
Covalent bonding	100	98	100	95	100	97
Ionic bonding	100	94	100	92	100	97
Kinetic-molecular theory of gases	100	76	100	71	100	88
K-shell	100	91	50	56	58	50
Oxidation-reduction	100	93	100	83	100	97
Periodic law(many properties of the elements are periodic functions of their atomic numbers)	100	86	100	71	96	76
pH	95	86	88	64	92	93

The criterion for inclusion of a topic in the lists in Tables VI-2, VI-3, and VI-4 was that more than ninety per cent of the appropriate group of teachers indicated that the topic was presented.

Topics in all three of the lists were the following:

Covalent bonding

Ionic bonding

Kinetic-molecular theory of gases

Oxidation-reduction

Periodic law

In view of the rather stringent criterion for the lists, the fact that five topics are on all three lists indicates that there is a sizable body of material presented in all or nearly all secondary school chemistry courses.

Topics found on only a single list are the following:

Chemical Bond Approach

Electronegativity
Enthalpy changes
Ideal gas

Chemical Education Material Study

Brönsted acids
Equilibrium constants
Le Chatelier's principle
Solubility product constant

Other courses

Anhydrides
K-shell

Even for most of these entries, at least fifty per cent of the teachers from the other courses report presenting the topic. The fact that fewer topics were reported as being taught by more than ninety per cent of teachers of versions of Modern Chemistry than are included on the CBA or CHEMS lists suggests a greater diversity of emphasis in the other courses than in those developed by curriculum groups.

Table VI-5 gives still a different insight into the emphasis that the topics have received. In this table are entered the cases where the percentages of teachers who consider the topic presented and the percentages of students who consider the topic presented differ by twenty-nine or more percentage points.

TABLE VI-5

Topics for Which the Percentages of Teachers Who Consider the Topic Presented and Students Who Consider the Topic Presented Differ Markedly

	Conventional		CBA		CHEMS	
	Teachers	Students	Teachers	Students	Teachers	Students
Activation energy			100	49		
Allotropes					54	25
Brönsted acids (proton donors)					96	63
Colloids			0	29		
Complex ions of the transition elements (coordination complexes of the transition elements)	0	29				
Conjugate acid-base pairs			81	51		
Contact process (commerical preparation of H_2SO_4)	58	94				
Coordinate covalent bonding			88	53		
Dipole moments			88	53		
Equilibrium constants					96	67
Free energy			81	44		
Graham's law on the rate of diffusion of gases			88	58		
Infrared spectrum			12	53		
Kinetic-molecular theory of gases			100	71		
Le Chatelier's principle	89	56	88	36		
Lewis acid(electron-pair receiver)	53	22	81	51	54	21
Oxidation potential or electrode potential (measure of the strength of a reducing agent in water solution)			75	46		
Periodic law (many properties of the elements are periodic functions of their atomic numbers)			100	71		
Radioactivity					81	50
Resonance			56	22	46	17

A satisfactory interpretation of the entries in Table VI-5 is not easily developed. One is inclined to suspect that the following data are significant:

TABLE VI-6

Number of Topics for Which a Significantly Higher Percentage of Teachers than Students Report Inclusion in Chemistry Courses

Topics from Conventional courses	2
Topics from CBA courses	12
Topics from CHEMS courses	6

It may be that topics selected for emphasis in the new courses are topics not likely to be presented--or at least not emphasized--in the chemistry portions of general science courses. It may also be that topics presented only in a single science course are the topics most likely to be forgotten by students.

Perhaps the topics selected for emphasis in the newly developed courses have not been worked over by as many different people as have the topics in the conventional courses. As a result, the teachers in the new courses may not have developed as effective presentations as they have for the more conventional topics and the students may thus have less to remember.

No doubt other explanations can also be developed. That there is some significance to the data is suggested by the fact that there are twenty topics for which the teachers report a significantly higher percentage of presentation than do the appropriate students, whereas for only four topics do a significantly higher percentage of the students report presentation than do the appropriate teachers.

Table VI-7 shows the percentages of December-January seniors from the three types of schools studied who considered each of the topics in the area of atomic structure and bonding to have been studied in their chemistry courses. Atomic structure and bonding topics were selected as a sample of the types of differences observed for other topics.

TABLE VI-7

Topics from Atomic Structure and Bonding Selected by December-January Questionnaire Respondents from Different Types of Schools as Having Been Studied

	Public Schools	Roman Catholic Schools	Other Schools
	%	%	%
Complex ions of the transition elements(coordination complexes of the transition elements)	31	29	30
Covalent bonding	96	96	95
Coordinate covalent bonding	66	59	61
Dipole moments	47	44	50
Electron affinity	70	73	79
Electronegativity	78	81	84
Infrared spectrum	30	36	39
Ionic bonding	95	96	93
Ionization potential	72	78	77
K-shell	86	87	82
Lattice	36	40	43
Metallic bonding(the forces holding metal atoms in the solid state)	62	68	73
Multiple proportions	66	71	62
π bonding	15	12	20
Quantum number	51	46	52
Radioactivity	65	72	61
Resonance	43	46	61

The topics for which the students report the biggest differences in presentation are metallic bonding, resonance, multiple proportions, and radioactivity. The first two are most commonly presented in the other schools, the last two in Roman Catholic schools.

For topics in the same area, atomic structure and bonding, Table VI-8 gives the percentages of December-January respondents from the different regions of the country who consider the topics to have been studied.

TABLE VI-8

Topics from Atomic Structure and Bonding Selected by December-January Questionnaire Respondents as Having Been Studied by Geographical Region

	Northeast	South	Midwest	West
	%	%	%	%
Complex ions of the transition elements(coordination complexes of the transition elements)	31	27	30	34
Covalent bonding	97	98	94	95
Coordinate covalent bonding	67	69	62	55
Dipole moments	43	49	50	53
Electron affinity	73	70	67	69
Electronegativity	85	74	72	70
Infrared spectrum	25	39	37	38
Ionic bonding	96	96	94	95
Ionization potential	73	68	75	76
K-shell	90	85	83	79
Lattice energy	36	39	36	40
Metallic bonding(the forces holding metal atoms in the solid state)	61	67	63	72
Multiple proportions	67	68	64	68
π bonding	13	13	15	19
Quantum number	47	44	54	61
Radioactivity	67	67	65	61
Resonance	45	45	44	43

The topics for which the student reports show the greatest variation along with the region in which the presentation of the topic is most different from the other three, are the following: coordinate covalent bonding (lowest in the West), dipole moments (lowest in the Northeast), electronegativity (highest in the Northeast), infrared spectrum (lowest in the Northeast), K-shell (highest in the Northeast), metallic bonding (highest in the West), quantum number (highest in the West).

These tables indicate that at least as far as the questionnaire respondents are concerned the topics presented in chemistry differ little among the types of school and among the regions of the country.

VII. College-Level Chemistry

The offering by secondary schools of a college-level course in chemistry has increased in recent years. This course may be either an Advanced Placement course of the kind related to the College Board Advanced Placement Program or a course unconnected with the national program. The Chemistry Questionnaire has provided information about such courses not previously available. A total of 319 students reported on their replies that they had taken or were taking a college-level chemistry course. The responses of all of these except for six students who said that they had been involved in both a second-year chemistry course and a college-level course were studied to obtain the information summarized below. Because of the small sample sizes, the data from the different administrations have not been weighted to reflect the total candidate population. The results presented are merely a tabulation of the data combined across administrations.

One concern about the taking of such courses is whether the college-level course replaces another science course. The information in the next few tables is related to this concern. When the biology, chemistry, and physics courses taken by these students were summarized, more than thirty different patterns were observed, the patterns differing in which of the three sciences were included in the patterns and in how many semesters of each of the sciences were taken. The order in which the courses was taken, however, was not considered. The most common of these patterns are given in Table VII-1.

TABLE VII-1

Patterns of Science Courses Taken by Chemistry Questionnaire Respondents Who Took a College-Level Chemistry Course

I.	1 year h.s. biology 1 year h.s. chemistry 1 year college chemistry 1 year h.s. physics	89 students
II.	1 year college biology 1 year college chemistry	49 students
III.	1 year college biology 1 year college chemistry 1 year college physics	29 students
IV.	1 year h.s. biology 1 year college chemistry	26 students
V.	1 year h.s. biology 1 year h.s. chemistry	18 students
VI.	1 year h.s. biology 1 year college chemistry 1 year h.s. physics	17 students
VII.	1 year h.s. biology 1 year college chemistry 1 year college physics	13 students
VIII.	1 year college chemistry	11 students
IX.	1 year h.s. chemistry 1 year college chemistry 1 year h.s. physics	10 students

In a few cases a physical science course which may have provided background for both a college chemistry course and a college physics course was included in the science program of these students.

Table VII-2 summarizes the selection of science courses in the three areas considered in this summary.

TABLE VII-2

Number of Questionnaire Respondents with a College-Level Chemistry Course and the Areas of Science in Which They Took Courses

Chemistry only	13 students
Chemistry and Physics only	23 students
Biology and Chemistry only	97 students
Biology, Chemistry, and Physics	180 students

Comparable data for the total group of Chemistry Questionnaire respondents are not available, but the data in a previous table suggest that there may have been some sacrificing of breadth of science courses taken in order to include a college chemistry course.

In view of the information in Table VII-1 and Table VII-2, the following quotation from the Chemistry section of Advanced Placement Program: 1966-1968 Course Descriptions may be interesting. "The advanced work in chemistry should not displace any other part of the student's science curriculum. It is highly desirable that a student have a course in secondary school physics and an uninterrupted program of mathematics. The physics could well precede the college-level chemistry."

Tables VII-3, VII-4, and VII-5 explore in further detail the secondary school courses taken by students who take college-level chemistry courses in secondary school.

TABLE VII-3

Percentages of Respondents with College-Level Chemistry Who Took Secondary School Courses in Specified Academic Areas and the Percentages for All December-January Senior Respondents by Grade and Course

Grade and Courses	Respondents with College-Level Chemistry	All December-January Senior Respondents
Ninth		
English	99	99
Mathematics	100	99
Social Science	75	80
Foreign Language	91	85
Science	82	82
Art, Music	37	44
Practical Arts	24	28
Tenth		
English	98	99
Mathematics	100	99
Social Science	56	63
Foreign Language	96	91
Science	90	87
Art, Music	23	32
Practical Arts	17	18
Eleventh		
English	98	99
Mathematics	100	97
Social Science	83	86
Foreign Language	83	73
Science	96	95
Art, Music	15	27
Practical Arts	14	18
Twelfth		
English	98	98
Mathematics	95	90
Social Science	76	81
Foreign Language	41	43
Science	96	93
Art, Music	17	26
Practical Arts	16	23

TABLE VII-4

Percentages of Respondents with College-Level Chemistry Who Took More Than One Course Concurrently in Specified Academic Areas and the Percentages for All December-January Senior Respondents

Grade and Courses	Respondents with College-Level Chemistry	All December-January Senior Respondents
Ninth		
English	5.4	4.5
Mathematics	0.0	1.0
Social Science	0.0	0.3
Foreign Language	2.7	2.1
Science	1.8	1.1
Art, Music	7.2	10.5
Practical Arts	0.0	2.6
Tenth		
English	4.5	5.6
Mathematics	1.8	1.3
Social Science	1.8	0.6
Foreign Language	14.4	11.2
Science	4.5	1.9
Art, Music	4.5	4.9
Practical Arts	0.9	2.1
Eleventh		
English	7.2	6.9
Mathematics	1.8	1.9
Social Science	0.0	1.4
Foreign Language	5.4	4.3
Science	5.4	4.5
Art, Music	3.6	3.8
Practical Arts	0.0	0.5
Twelfth		
English	8.1	10.7
Mathematics	3.6	5.9
Social Science	7.2	6.7
Foreign Language	2.7	1.8
Science	27.9	16.3
Art, Music	1.8	4.3
Practical Arts	0.9	2.7

TABLE VII-5

Percentages of Respondents with College-Level Chemistry Who Took Certain Science Courses by Year in Secondary School and Percentages for All December-January Respondents

Grade and Courses	Respondents with College-Level Chemistry	All December-January Senior Respondents
Ninth		
General Science	40	49
Biology, 1st h.s. course	31	18
Chemistry, 1st h.s. course	1	.3
Earth Science	6	8
Other	3	2
Tenth		
Biology, 1st h.s. course	37	62
Biology, college level	13	4
Biology, 2nd h.s. course	4	3
Chemistry, 1st h.s. course	30	12
Physics, 1st h.s. course	4	2
Earth Science	.9	.8
General Science	.4	.9
Other	2	2
Eleventh		
Chemistry, 1st h.s. course	33	68
Chemistry, college level	31	5
Chemistry, 2nd h.s. course	.9	3
Physics, 1st h.s. course	31	14
Physics, college level	.9	.5
Physics, 2nd h.s. course	.9	.4
Biology, 1st h.s. course	.9	1
Biology, college level	1	.5
Other	2	2
Science Seminar	.4	.4
Twelfth		
Physics, 1st h.s. course	30	61
Physics, college level	21	5
Physics, 2nd h.s. course	1	3
Chemistry, 1st h.s. course	.4	7
Chemistry, college level	63	11
Chemistry, 2nd h.s. course	2	7
Biology, 1st h.s. course	.4	.7
Biology, college level	2	1
Biology, 2nd h.s. course	1	2
Other	2	4
Science Seminar	2	2

Table VII-3 shows that the students with college-level chemistry take somewhat more science, mathematics, and foreign language and somewhat less social studies and art and/or music than the total group of Chemistry Questionnaire respondents. According to Table VII-4 the students with college-level chemistry are more likely to take concurrently two or more courses in science and in foreign language but are less likely to take concurrent courses in mathematics than the total group of respondents. Table VII-5 indicates the magnitude of the shift in the sequence of science courses selected by the students with college-level chemistry. For these people almost as many take biology as freshmen as take it as sophomores and the percentage in freshmen general science drops but not as dramatically as might have been predicted. The percentages of sophomores in secondary school chemistry, of juniors in secondary school chemistry, college-level chemistry, and secondary school physics, and of seniors in secondary school physics are nearly the same. This table also makes clear that most of these students take their college-level chemistry as seniors and that these people are about four times as likely to take college-level physics as are the Chemistry Questionnaire respondents in general.

The scheduling of courses for students who took four or more years of secondary school science including a college-level chemistry course is of interest because the program usually requires some sort of adjustment for the inclusion of the college-level course. The widely used approaches to this scheduling are indicated in Table VII-6.

TABLE VII-6

Numbers of Questionnaire Respondents with College-Level Chemistry Who Used Certain Plans of Scheduling Four or More Secondary School Science Courses

One science course every secondary school semester and never two science courses in the same semester	42 students
Science every semester and more than one science course in some semesters	44 students
One or more semesters with no science, other semesters with more than one science course	15 students
One or two semesters with no science, no semester with more than one science course	4 students

About forty per cent of the students described in Table VII-6 obviously took a science course in addition to secondary school biology, secondary school and college chemistry, and secondary school physics. Usually this was general science, earth science, or physical science. In a few cases one of the four courses was shortened by a semester in order to help fit in the four courses, but this was not a common arrangement.

Important information about college-level chemistry courses can be obtained by a study of the textbooks used in these courses. Table VII-7 gives this information for the students who took a college-level chemistry course without having had a secondary school chemistry course first.

TABLE VII-7

Frequency of Mention of Primary Textbooks by Questionnaire Respondents Who Took a College-Level Chemistry Course as Their First Secondary School Chemistry Course

Baker and others	Chemistry and You	2
Brownlee and others	Elements of Chemistry	2
Chemical Bond Approach Project	Chemical Systems	9
Chemical Education Material Study	Chemistry: An Experimental Science	47
Dorf and others	Chemistry for the Nuclear Age	1
Dull and others or Metcalfe and others	Modern Chemistry	72
Garrett and others	Chemistry: A First Course in Modern Chemistry	4
Hogg and others	Physics and Chemistry: A Unified Approach	2
Pauling	College Chemistry	2
Sienko and Plane	Chemistry	11
Young and Petty	Chemistry for Progress	1
No primary text		3

Table VII-8 gives the frequency with which texts were indicated by the students with a college-level chemistry course which followed a secondary school chemistry course.

TABLE VII-8

Frequency of Mentioned Primary Textbooks by Questionnaire Respondents Who Took a College-Level Chemistry Course Following Secondary School Chemistry

Chemical Bond Approach Project	Chemical Systems	3
Chemical Education Material Study	Chemistry: An Experimental Science	3
Dull and others or Metcalfe and others	Modern Chemistry	4
Keenan and Wood	General College Chemistry	2
Nebergall and Schmidt	General Chemistry	9
Pauling	College Chemistry	4
Quagliano	Chemistry	8
Sienko and Plane	Chemistry	76
Sisser and others	College Chemistry: A Systematic Approach	4
Sorum	Fundamentals of General Chemistry	4
No primary text		8

Several other texts were mentioned once by other students.

A study of Tables VII-7 and VII-8 suggests that the college-level chemistry courses offered in secondary schools are of two different sorts depending on whether or not the students have had a previous secondary school chemistry course. The texts used in those courses that are the first secondary school chemistry courses are predominantly texts designed for secondary school courses while the texts in the courses that are second chemistry courses are predominantly the texts widely used in first-year college chemistry courses. Although the text used in a course is not always indicative of the level of the course, the level of most courses does not differ greatly from the level of their texts.

VIII. Second-Year Chemistry

To provide information on the nature of the courses that are called second-year high school chemistry courses, the questionnaires of 198 students who indicated that they had taken such a course were studied in some detail. These were all the students who had checked the space indicating that they had taken or were taking "chemistry-2nd year h.s. course (other than a college-level course)" except for six students who said that they had taken or were taking both a second-year course and a college-level course. Because of the small sample sizes, the data from the different administrations have not been weighted to reflect the total candidate population. The results presented are merely a tabulation of the data combined across administrations.

When the biology, chemistry, and physics courses of these students were examined, more than forty different patterns were observed, the patterns differing in which of the three courses had been selected and in the number of semesters of each of the courses that had been taken. Differences in the order in which the courses were taken were not counted as different patterns. The number of semesters of each of the courses ranged from one to six.

A few patterns emerged as being fairly common. These and their frequencies are listed in Table VIII-1.

TABLE VIII-1

Patterns of Science Courses Taken by Questionnaire Respondents Who Took a Second-Year Secondary School Chemistry Course

I.	1 year h.s. biology 1 year h.s. chemistry 1 year second year chemistry 1 year h.s. physics	61 students
II.	1 year second year biology 1 year second year chemistry 1 year second year physics	20 students
III.	1 year second year biology 1 year second year chemistry	17 students
IV.	1 year h.s. biology 1 year second year chemistry	14 students
V.	1 year h.s. biology 1 year h.s. chemistry 1 year second year chemistry	11 students
VI.	1 year h.s. biology 1 year second year chemistry 1 year second year physics	9 students

In a few cases a physical science course was included in the science courses of students otherwise represented by the patterns above.

Table VIII-2 is a summary of the science areas selected by the students who took second-year chemistry courses.

TABLE VIII-2

Number of Questionnaire Respondents with a Second-Year Secondary School Chemistry Course and the Areas of Science in Which They Took Courses

Chemistry only	6 students
Chemistry and physics only	9 students
Biology and chemistry only	51 students
Biology, chemistry, and physics	132 students

A total of 89 of these students took at least some biology, some secondary school chemistry, some second year chemistry, and some secondary school physics. The patterns of scheduling this amount of science during the four secondary school years are suggested by the information in Table VIII-3.

TABLE VIII-3

Number of Questionnaire Respondents with Second-Year Secondary School Chemistry Who Used Certain Plans of Scheduling Four or More Secondary School Science Courses

One science course every h.s. semester and never two science courses in the same semester	22 students
Science every semester and more than one science course in some semesters	45 students
One or more semesters with no science, other semesters with more than one science course	20 students
One or two semesters with no science, no semester with more than one science course	2 students

Most of the students who took the commonest combination of biology, second-year chemistry, and physics clearly took science courses in addition to the four courses. Most commonly this was a general science course, a physical science course, or an earth science course during the freshman year. Furthermore, most of the students with a second-year chemistry course took more than one science course during at least one of the high school years.

An indication of the nature of this second-year chemistry course can be obtained from students who took a second-year chemistry course without having had a secondary school chemistry course.

TABLE VIII-4

Frequency with Which Primary Textbooks Were Mentioned by Questionnaire Respondents Who Took Second-Year High School Chemistry as Their First High School Chemistry Course

Baker and others	Chemistry and You	4
Chemical Bond Approach Project	Chemical Systems	1
Chemical Education Material Study	Chemistry: An Experimental Science	12
Dorf and others	Chemistry for the Nuclear Age	1
Dull and others or Metcalfe and others	Modern Chemistry	43
Fliedner and Teichman	Chemistry: Man's Servant	2
Garrett and others	Chemistry: A First Course in Modern Chemistry	4
Hogg and others	Chemistry: A Basic Science	2
Hogg and others	Chemistry, A Modern Approach	3
Jaffe	New World of Chemistry	1
Lanford	Using Chemistry	1
Smoot and others	Chemistry, A Modern Course	1
No primary text		1

About a dozen students whose texts are listed in Table VIII-3 named supplementary texts. Table VIII-5 lists these supplementary texts and the frequencies with which they were mentioned. Several students listed more than one of these supplementary texts.

TABLE VIII-5

Frequency with Which Supplementary Texts Were Mentioned by the Questionnaire Respondents Included in Table VIII-3

Arthur	Chemistry for Today	1
Brownlee and others	Elements of Chemistry	3
Chemical Bond Approach Project	Chemical Systems	1
Chemical Education Material Study	Chemistry: An Experimental Science	2
Dull and others or Metcalfe and others	Modern Chemistry	3
Fliedner and Teichman	Chemistry: Man's Servant	2
Hogg and others	Chemistry: A Basic Science	1
Keenan and Wood	General College Chemistry	1
Nebergall and Schmidt	General Chemistry	2
Pauling	College Chemistry	3
Quagliano	Chemistry	1
Sienko and Plane	Chemistry	4
Sisler and others	College Chemistry: A Systematic Approach	1

Particularly striking is the fact that all the primary texts listed by students who took a second-year chemistry course without having taken a first-year secondary school course are generally considered secondary school chemistry texts. Furthermore, more than half the texts mentioned as supplementary texts are secondary school chemistry texts.

The primary texts noted by students of second year chemistry courses which followed a secondary school chemistry course are listed in Table VIII-6, along with the frequencies with which these texts were mentioned. Laboratory manuals, calculations books, and review books have not been included in the list.

TABLE VIII-6

Frequency with Which Primary Textbooks Were Mentioned by Questionnaire Respondents Who Took Both First-Year and Second-Year High School Chemistry

Baker and others	Chemistry and You	1
Chemical Bond Approach Project	Chemical Systems	4
Chemical Education Materials Study	Chemistry: An Experimental Science	13
Choppin and Jaffee	Chemistry: Science of Matter, Energy	1
Dull and others or Metcalfe and others	Modern Chemistry	9
Felsing and Watt	General Chemistry	1
Frey	College Chemistry	1
Garrett and others	Chemistry: A First Course in Modern Chemistry	1
Gregg	College Chemistry	1
Fieser and Fieser	Basic Organic Chemistry	1
Hart and Schuetz	A Short Course in Organic Chemistry	2
Hogg and others	Physics and Chemistry: A Unified Approach	1
King and Caldwell	Fundamentals of College Chemistry	1
Lanford	Using Chemistry	1
Mack and others	Textbook of Chemistry	1
Morrison and Boyd	Organic Chemistry	1
Nebergall and Schmitt	College Chemistry	2
Nebergall and Schmitt	General Chemistry	5
Pauling	College Chemistry	4
Quagliano	Chemistry	6
Ryschkewitsch	Chemical Bonding and the Geometry of Molecules	1
Selwood	General Chemistry	1
Sienko and Plane	Chemistry	26
Sisler and others	College Chemistry: A Systematic Approach	1
Smoot and others	Chemistry, A Modern Course	3

Most of the respondents with a second-year secondary school chemistry course that followed a first-year course indicated primary texts used in introductory college chemistry courses.

If one judges from the texts used one suspects that some college-level courses might well be called second-year secondary school courses and that some of the second-year courses approach and perhaps reach the level of college courses.

Conclusions

For the members of the Committee of Examiners for the College Board Chemistry Achievement Test, no doubt the most important conclusions are that secondary school chemistry does not differ greatly among the types of secondary schools, from one region of the country to the others, or even among the topics covered in courses of the three major types. There are differences, but the similarities are great enough to support a nationwide chemistry achievement test at the present time.

A rather disturbing conclusion is that the phrases, "college-level course" and "second-year course," are fairly often used by secondary schools for courses that seem not to merit such titles because a good many of these courses use popular secondary-school chemistry textbooks.

Appendix I

Details of Design and Administration of Survey

Sampling Plan

All students who had taken College Board achievement tests during the 1965-1966 academic year provided the sampling frame for the survey. The selection procedure provided for drawing nonoverlapping samples of equal size for each subject within an administration, with one restriction: only juniors were to be drawn from the May test population. Also deleted were college and postgraduate students, and students attending secondary schools located in areas other than the 50 states. In actual numbers, this meant 975 cases for each subject from the December, January, and May administrations and 675 cases per subject from the March administration.

In case a student took tests at different administrations and thus could have been selected for more than one sample, the student was asked to complete and return only the first questionnaire that he received. Whenever the data from samples taken from several administrations or samples from different tests within an administration were combined for presentation in one of these reports, the responses were weighted in proportion to the total population that they represented.

Sample selection was based on the three-digit number formed by reversing the last three digits of the candidate's registration number. That is, if the registration number was designated by 6543210, then 012 was the number used in sample selection. In order to be included in the sample for a particular test, a student had to have a registration number in which the number 012 belonged to a set of special values. He also had to have an achievement test score, which meant that students who registered but did not take the test were eliminated from the study.

Because of the variability in the total numbers of students who take achievement tests in different subjects, top priority in assigning sets of values was given to the subjects taken by the least number of students. For example, in the May administration the number of candidates was small. In order that large enough sample sizes would be obtained, the acceptable values of 012 for the various tests had to be overlapped. To make sure that even though a candidate qualified for two samples he was selected for only one, top priority was given to German, Latin, Spanish, French, and Biology. In contrast, in the December administration, only the values for German overlapped the other subjects.

Description of the Questionnaire

Each of the eight different questionnaires used in this survey had three parts: Part I described general course work in grades 9 through 12 in seven general areas: English, mathematics, history and social studies, foreign languages (modern and classical), sciences, art and music, and practical arts; Part II provided detailed information on the specific courses taken by the candidates in one of five general areas (area dependent on the test for which the candidate was selected); Part III focused primarily on either course content or methodology in the subject in which the candidate took a College Board achievement test.

The Committees of Examiners participated in preparing the questionnaires as well as in planning their analyses. The answer sheets were scored by DIGITEK.

Each questionnaire was accompanied by a general letter of invitation which emphasized the necessity for accurate information and urged students to seek their teachers' assistance whenever necessary.

Administration of the Questionnaires

A preprinted code number appeared on each Part I answer sheet. This unique candidate number has six digits. The first digit identified the part (Part I, II, or III); the second digit identified the subject and was the same as the number which appeared on the appropriate questionnaire booklet; the remaining four digits identified the candidate.

In mailing the materials, the addresses used were those provided by the students on their registration forms. In most cases, these were the students' home addresses. Care was taken that the mailing label prepared by the computer had the same number as that on the answer sheet for Part I and that the questionnaire booklet number agreed with that part of the candidate number which identified the subject in which he had taken an achievement test.

The access to a special tape was a convenient means for obtaining information such as test scores (including scores on all College Board achievement tests and on the Scholastic Aptitude test), school, and, in some instances, background information on candidate preparation in the subject in which he took the test. It also provided a system for following up on nonrespondents as well as for informing principals as to which students in their schools received questionnaires and which students had not returned completed forms.

Response to Survey

The excellent cooperation of both students and principals resulted in returns from three-fourths of the candidates contacted. However, close to 5 per cent, for one reason or another, were not usable. As noted on the following page, these responses vary—from a low of 61 per cent for those who took the history tests to a high of 76 per cent for those who took the physics test. Accompanying letters from students, teachers, and administrators indicated appreciation of the desire of the College Board to assure all students an equal opportunity of showing on the tests what they had learned, even though their secondary school programs were different.

Additional Comments

As indicated previously, the students submitting data for these reports represent an atypical group of prospective college students. Compared with a national sample of college entrants (College Board Score Reports, 1967-68), they rank close to the 75th percentile on the Scholastic Aptitude test, Verbal and Mathematical.

It is not too surprising to find that this is an extremely able group because, other things being equal, a college that uses achievement tests is likely to have applicants of high academic ability and good preparation.

RESPONSE SUMMARY SHEET

Subject	Number Contacted	Number of Usable Returns	Per Cent Response
English	3,474	2,313	68%
American History European History	5,137	3,079	61
French	3,486	2,600	75
German	3,487	2,579	75
Spanish	3,452	2,447	71
Latin	3,540	2,595	74
Mathematics Level I Mathematics Level II	5,448	3,769	70
Biology	3,379	2,275	68
Chemistry	3,338	2,458	75
Physics	3,373	2,513	76
Totals	38,114	26,628	71%

APPENDIX II

GENERAL INSTRUCTIONS

This questionnaire consists of three parts, the answers to which are to be entered on the two response sheets enclosed in this booklet. The questions and instructions for completing the first two parts are given directly on the response sheets. However, the questions and instructions for completing the third part are contained in this booklet beginning on page 81.

To indicate your answers to the questions, blacken the appropriate boxes on the response sheets. BE SURE THAT EACH MARK IS MADE WITH A BLACK PENCIL AND THAT IT FILLS THE BOX. If you change an answer, be sure that you erase all previous marks. Incomplete erasures may be read as intended answers.

Please do not write any answers in this booklet since only the response sheets are to be returned for processing.

When you have completed this questionnaire, insert the two response sheets (UNFOLDED) in the enclosed prepaid business reply envelope and return them to the Educational Testing Service. The cardboard inserted in this envelope is for the protection of your response sheets in the return mail.

In the event you have already completed a questionnaire in connection with this survey, please return this set of materials BUT ONLY AFTER YOU HAVE ANSWERED QUESTION 1 ON THE PART I RESPONSE SHEET.

COLLEGE BOARD CANDIDATE SURVEY: Part I

1 PREVIOUS PARTICIPATION

HAVE YOU, DURING THIS SCHOOL YEAR, PREVIOUSLY COMPLETED AND RETURNED A QUESTIONNAIRE IN CONNECTION WITH THIS SURVEY?

YES
NO

IF YOU MARKED "YES," PLEASE RETURN THIS QUESTIONNAIRE UNANSWERED.

IF YOU MARKED "NO," PLEASE COMPLETE THIS QUESTIONNAIRE.

2 NAME AND SCHOOL

YOUR NAME: ____________________

SCHOOL NAME: ____________________

SCHOOL ADDRESS: ____________________
STREET
____
CITY
____
STATE

3 GRADE

WHAT GRADE ARE YOU IN?

10TH
11TH
12TH
OTHER

4 RANK IN CLASS

WHAT IS YOUR RANK IN CLASS WITH RESPECT TO ALL STUDENTS IN YOUR GRADE? ESTIMATE IF NECESSARY.

FIRST OR TOP QUARTER
SECOND QUARTER
THIRD QUARTER
FOURTH OR BOTTOM QUARTER

5 ADVANCED PLACEMENT EXAMINATIONS

DIRECTIONS:

BLACKEN THE APPROPRIATE BOX FOR EACH COLLEGE BOARD ADVANCED PLACEMENT EXAMINATION THAT YOU HAVE ALREADY TAKEN AT LEAST ONCE (BOX "H") OR WILL TAKE FOR THE FIRST TIME IN MAY, 1966 (BOX "W").

NOTE:

THE CEEB ADVANCED PLACEMENT EXAMINATIONS COVER COLLEGE-LEVEL WORK WHICH STUDENTS TAKE WHILE IN HIGH SCHOOL AND FOR WHICH MANY COLLEGES GRANT CREDIT AND/OR ADVANCED STANDING TO STUDENTS WHO DO WELL ON THESE EXAMINATIONS.

AMERICAN HISTORY	FRENCH
BIOLOGY	GERMAN
CHEMISTRY	LATIN 4 OR 5
ENGLISH	MATHEMATICS
EUROPEAN HISTORY	PHYSICS
	SPANISH

6 CREDIT COURSES COMPLETED AS OF JUNE, 1966

DIRECTIONS:

PLEASE INDICATE THE NUMBER OF CREDIT COURSES THAT YOU HAVE COMPLETED (OR WILL COMPLETE) BY JUNE, 1966 IN EACH OF THE SUBJECT AREAS LISTED AT THE RIGHT. FOR EACH SEMESTER IN WHICH YOU TOOK ONE OR MORE COURSES IN A SPECIFIED AREA, BLACKEN THE ONE BOX WHICH INDICATES THE NUMBER OF COURSES THAT YOU TOOK. CONSIDER THAT A YEAR IN SECONDARY SCHOOL GENERALLY CONSISTS OF TWO SEMESTERS, EACH OF WHICH IS FOUR OR FIVE MONTHS IN LENGTH.

WHEN INDICATING COURSES FOR GRADES 9 THROUGH 12 AND SUMMER SCHOOL (1963, 1964, 1965), DO NOT INCLUDE COURSES SUCH AS PHYSICAL EDUCATION, FIRST AID, AND DRIVER EDUCATION. ALSO, DO NOT INCLUDE MAKE-UP OR REMEDIAL COURSES, OR COURSES TAKEN FOR A SECOND TIME IN ORDER TO IMPROVE YOUR GRADES. INCLUDE COURSES FOR ACCELERATION OR ENRICHMENT AND SEMINARS OR INSTITUTES IN THE ACADEMIC AREAS LISTED SUCH AS THOSE SPONSORED BY THE NATIONAL SCIENCE FOUNDATION.

	GRADE →	9		10		11		12		SUMMER SCHOOL
	SEMESTER →	1	2	1	2	1	2	1	2	
ENGLISH: (INCLUDING CREDIT COURSES SUCH AS DEBATING, DRAMA, JOURNALISM, AND SPEECH)	NO. OF COURSES: ONE									63
	TWO									64
	THREE OR MORE									65
MATHEMATICS: (NOT INCLUDING COURSES SUCH AS ACCOUNTING, BOOKKEEPING, AND BUSINESS ARITHMETIC. INCLUDE THESE IN THE PRACTICAL ARTS SECTION BELOW.)	NO. OF COURSES: ONE									63
	TWO									64
	THREE OR MORE									65
HISTORY, SOCIAL STUDIES, AND THE SOCIAL SCIENCES: (INCLUDING COURSES SUCH AS CIVICS, ECONOMICS, PROBLEMS OF DEMOCRACY, PSYCHOLOGY, SOCIOLOGY, AND STATE HISTORY)	NO. OF COURSES: ONE									63
	TWO									64
	THREE OR MORE									65
FOREIGN LANGUAGES: (MODERN AND CLASSICAL)	NO. OF COURSES: ONE									63
	TWO									64
	THREE OR MORE									65
SCIENCE: (INCLUDING COURSES SUCH AS BIOLOGY, CHEMISTRY, EARTH SCIENCE, GENERAL SCIENCE, PHYSICS, AND PHYSIOLOGY)	NO. OF COURSES: ONE									63
	TWO									64
	THREE OR MORE									65
ART AND MUSIC: (INCLUDING REQUIRED OR ELECTIVE COURSES IN APPRECIATION, HISTORY, THEORY OR COMPOSITION, DRAWING, CHOIR, AND ORCHESTRA)	NO. OF COURSES: ONE									63
	TWO									64
	THREE OR MORE									65
PRACTICAL ARTS: (INCLUDING COURSES IN AGRICULTURE, BUSINESS AND COMMERCE, TYPING, SPEEDWRITING, HOME ECONOMICS, INDUSTRIAL ARTS, AND VOCATIONAL AND TRADE EDUCATION	NO. OF COURSES: ONE									63
	TWO									64
	THREE OR MORE									65

EXAMPLE:

IF YOU TOOK ONLY ONE ENGLISH COURSE IN THE FALL SEMESTER OF THE NINTH GRADE, YOU WOULD BLACKEN BOX 1, UNDER GRADE 9, SEMESTER 1, AS SHOWN IN THE EXAMPLE BELOW.

IF YOU TOOK TWO ENGLISH COURSES IN THE SPRING SEMESTER OF THE NINTH GRADE, YOU WOULD BLACKEN BOX 2 UNDER GRADE 9, SEMESTER 2.

IF YOU STUDIED ENGLISH IN SUMMER SCHOOL IN 1964, YOU WOULD BLACKEN THE BOX LABELED 64 IN THE COLUMN HEADED SUMMER SCHOOL.

	GRADE →	9		10		11		12		SUMMER SCHOOL
	SEMESTER →	1	2	1	2	1	2	1	2	
ENGLISH	NO. OF COURSES: ONE	■								
	TWO		■							■
	THREE OR MORE									

DO NOT WRITE IN THIS AREA →

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EDUCATIONAL TESTING SERVICE
PRINCETON, N.J

DC125P56M

COLLEGE BOARD CANDIDATE SURVEY: Part II-Sciences

COURSES COMPLETED IN THE SCIENCES AS OF JUNE, 1966

DIRECTIONS:

PLEASE COMPLETE TABLES A AND B TO SHOW ALL OF THE CREDIT COURSES IN SCIENCE THAT YOU HAVE COMPLETED OR WILL COMPLETE BY JUNE, 1966. MOST OF YOUR WORK IN SCIENCE WILL BE RECORDED IN TABLE A. TABLE B IS TO BE USED ONLY IF YOU TOOK TWO DIFFERENT SCIENCE COURSES DURING THE SAME SEMESTER OR SUMMER.

A LIST OF SCIENCE COURSES AND THEIR RESPECTIVE CODE NUMBERS IS GIVEN AT THE RIGHT. FIRST, READ THROUGH THE LIST OF COURSES. BEGINNING AT THE NINTH GRADE AND FOR EACH SEMESTER AND SUMMER IN WHICH YOU TOOK ONE OR MORE SCIENCE COURSES, COPY IN THE BOXES TO THE RIGHT OF THE ARROWS IN TABLES A AND B THE CODE NUMBERS DESIGNATING THE SCIENCE COURSES WHICH APPROXIMATE IN CONTENT THE COURSES YOU HAVE COMPLETED OR WILL COMPLETE BY JUNE, 1966. AFTER YOU HAVE COPIED THE TWO-DIGIT CODE NUMBER FOR EACH COURSE, GO DOWN THE COLUMN UNDER EACH DIGIT OF THE CODE NUMBER AND BLACKEN THE BOX IN WHICH THE DIGIT APPEARS. AN EXAMPLE SHOWING HOW THESE TABLES SHOULD BE COMPLETED APPEARS IN THE QUESTIONNAIRE BOOKLET.

DO NOT INCLUDE MAKE-UP OR REMEDIAL COURSES OR COURSES TAKEN FOR A SECOND TIME IN ORDER TO IMPROVE YOUR GRADES. INCLUDE COURSES FOR ACCELERATION OR ENRICHMENT AND SEMINARS OR INSTITUTES SUCH AS THOSE SPONSORED BY THE NATIONAL SCIENCE FOUNDATION.

IF YOU HAVE TAKEN ANY SCIENCE COURSES IN AREAS OTHER THAN THOSE LISTED, ENTER CODE 42 IN THE BOXES CORRESPONDING TO THE SEMESTERS AND SUMMERS IN WHICH YOU TOOK THESE COURSES. PRINT IN THE SPACE PROVIDED AT THE RIGHT THE NAMES OF THESE COURSES AND WHEN THEY WERE TAKEN.

SHOULD YOU HAVE TAKEN MORE THAN TWO COURSES IN ANY SEMESTER OR SUMMER, SELECT FOR RECORDING IN TABLES A AND B THE TWO COURSES WHICH YOU FEEL CONTRIBUTED MOST TO YOUR KNOWLEDGE OF SCIENCE. INFORMATION ABOUT ADDITIONAL COURSES SHOULD BE REPORTED IN THE SPACE PROVIDED AT THE RIGHT.

COURSE LIST

CODE NO.	
11	GENERAL SCIENCE-9TH GRADE
12	BIOLOGY-1ST YEAR H.S. COURSE
13	BIOLOGY-COLLEGE LEVEL COURSE (INCLUDING CEEB ADVANCED PLACEMENT BIOLOGY)
14	BIOLOGY-2ND YEAR H.S. COURSE (OTHER THAN A COLLEGE LEVEL COURSE)
15	CHEMISTRY-1ST YEAR H.S. COURSE
21	CHEMISTRY-COLLEGE LEVEL COURSE (INCLUDING CEEB ADVANCED PLACEMENT CHEMISTRY)
22	CHEMISTRY-2ND YEAR H.S. COURSE (OTHER THAN A COLLEGE LEVEL COURSE)
23	PHYSICS-1ST YEAR H.S. COURSE
24	PHYSICS-COLLEGE LEVEL COURSE (INCLUDING CEEB ADVANCED PLACEMENT PHYSICS)
25	PHYSICS-2ND YEAR H.S. COURSE (OTHER THAN A COLLEGE LEVEL COURSE)
31	AVIATION OR AERONAUTICS
32	EARTH SCIENCE
33	GEOLOGY
34	PHYSICAL GEOGRAPHY
35	ASTRONOMY
41	A PHYSICAL OR BIOLOGICAL SCIENCE SEMINAR OR INSTITUTE
42	A PHYSICAL OR BIOLOGICAL SCIENCE COURSE OTHER THAN THOSE LISTED ABOVE

LIST ALL COURSES CODED "42" HERE

TITLE (PRINT)	GRADE (9–12)	SEMESTER (1 OR 2)

LIST THIRD COURSES HERE

TITLE (PRINT)	GRADE (9–12)	SEMESTER (1 OR 2)

TABLE A

	GRADE 9		GRADE 10		GRADE 11		GRADE 12			SUMMER'63	SUMMER '64	SUMMER'65
	SEM. 1	SEM. 2	SEM. 1	SEM. 2	SEM. 1	SEM. 2	SEM. 1	SEM. 2				
	CODE	CODE	CODE	CODE	CODE	CODE	CODE	CODE		CODE	CODE	CODE
ENTER CODE NUMBERS HERE →									ENTER CODE NUMBERS HERE →			
	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0		0 0	0 0	0 0
	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1		1 1	1 1	1 1
	2 2	2 2	2 2	2 2	2 2	2 2	2 2	2 2		2 2	2 2	2 2
	3 3	3 3	3 3	3 3	3 3	3 3	3 3	3 3		3 3	3 3	3 3
	4 4	4 4	4 4	4 4	4 4	4 4	4 4	4 4		4 4	4 4	4 4
	5 5	5 5	5 5	5 5	5 5	5 5	5 5	5 5		5 5	5 5	5 5

TABLE B: USE ONLY TO CODE THE SECOND OF TWO COURSES TAKEN AT THE SAME TIME IN ANY ONE SEMESTER OR SUMMER.

	GRADE 9		GRADE 10		GRADE 11		GRADE 12			SUMMER'63	SUMMER '64	SUMMER'65
	SEM. 1	SEM. 2	SEM. 1	SEM. 2	SEM. 1	SEM. 2	SEM. 1	SEM. 2				
	CODE	CODE	CODE	CODE	CODE	CODE	CODE	CODE		CODE	CODE	CODE
ENTER CODE NUMBERS HERE →									ENTER CODE NUMBERS HERE →			
	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0		0 0	0 0	0 0
	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1		1 1	1 1	1 1
	2 2	2 2	2 2	2 2	2 2	2 2	2 2	2 2		2 2	2 2	2 2
	3 3	3 3	3 3	3 3	3 3	3 3	3 3	3 3		3 3	3 3	3 3
	4 4	4 4	4 4	4 4	4 4	4 4	4 4	4 4		4 4	4 4	4 4
	5 5	5 5	5 5	5 5	5 5	5 5	5 5	5 5		5 5	5 5	5 5

DO NOT WRITE IN THE AREA BELOW.

0	0	0	0	0	0
1	1	1	1	1	1
2	2	2	2	2	2
3	3	3	3	3	3
4	4	4	4	4	4
5	5	5	5	5	5
6	6	6	6	6	6
7	7	7	7	7	7
8	8	8	8	8	8
9	9	9	9	9	9

PLEASE BE SURE THAT YOU HAVE COMPLETED BOTH SIDES OF THIS SHEET. DC 1640 DO NOT FOLD.

DIGITEK. Optical Scanning Systems. [illegible]

EDUCATIONAL TESTING SERVICE
PRINCETON, N.J.

DC125P15M

PART III - PREPARATION IN CHEMISTRY

Instructions for Completing Part III:

Students who are being asked to complete this questionnaire will have taken the College Board Chemistry Achievement Test at different times during the 1965-66 school year. So that the data collected from their questionnaires can be analyzed in a meaningful way, students are asked to answer all questions in terms of when they studied chemistry in high school and when they took the Chemistry Test. Please read the following instructions carefully before you begin to work on this questionnaire.

If you completed your high school study of chemistry before you took the Chemistry Test, answer the questions on the basis of all of your course work in chemistry regardless of whether you took the Chemistry Test in December 1965 or in January, March or May 1966.

If you were studying chemistry during the 1965-66 school year and took the Chemistry Test in

(a) DECEMBER 1965 or JANUARY 1966, answer the questions in terms of the chemistry you had studied up to the end of the fall (or first) semester of the 1965-66 school year.

(b) MARCH 1966, answer the questions in terms of the chemistry you had studied up to the time you took the Chemistry Test.

(c) MAY 1966, answer the questions in terms of the chemistry you studied up to the end of the 1965-66 school year.

Students who took the Chemistry Test at more than one of the administrations specified above should follow the instructions for the date on which they most recently took the test.

GO ON TO THE NEXT PAGE.

A - TOPICS STUDIED

Listed below are topics that are sometimes studied in chemistry courses. Probably no one course ever includes all of these topics. You are to indicate your familiarity with each topic--as of the time specified in the preceding instructions--by blackening one of the three boxes provided for that topic on the Response Sheet.

Blacken box "C"	if you are certain that you had studied the topic in one or more of your chemistry courses. Also blacken this box if you had learned about the topic both in your chemistry courses and elsewhere, such as in other courses or through independent study.
Blacken box "E"	if you know that you had not studied the topic in any of your chemistry courses but had studied the topic elsewhere, such as in other courses or through independent study.
Blacken box "U"	if you were unfamiliar with the topic or if you are uncertain as to whether you had studied the topic.

1. activation energy
2. alkanes (methane hydrocarbons)
3. allotropes
4. anhydrides
5. Brönsted acids (proton donors)
6. buffers
7. colloids
8. complex ions of the transition elements (coordination complexes of the transition elements)
9. conjugate acid-base pairs
10. contact process (commercial preparation of H_2SO_4)
11. covalent bonding
12. coordinate covalent bonding
13. destructive distillation
14. dipole moments
15. electron affinity
16. electronegativity
17. enthalpy changes (changes in the heat stored in a system)
18. equilibrium constants
19. fermentation
20. free energy
21. free radical reactions
22. Graham's law on the rate of diffusion of gases
23. hydrogenation
24. hydrolysis (decomposition as a result of the splitting of a bond and the addition of H and OH groups)
25. ideal gas
26. infrared spectrum
27. ionic bonding
28. ionization potential
29. cis and trans isomers
30. kinetic-molecular theory of gases
31. K-shell
32. lattice energy
33. Le Chatelier's principle
34. Lewis acid (electron-pair receiver)

35. metallic bonding (the forces holding metal atoms in the solid state)

36. multiple proportions

37. normality

38. Ostwald process (commercial preparation of HNO_3)

39. oxidation potential or electrode potential (measure of the strength of a reducing agent in water solution)

40. oxidation-reduction

41. paramagnetism (related to the number of unpaired electrons in the atoms or molecules of a substance)

42. periodic law (many properties of the elements are periodic functions of their atomic numbers)

43. pH

44. π bonding

45. phase diagram

46. quantum number

47. radioactivity

48. reaction rate (reaction rate constant)

49. resonance

50. solubility product constant

51. Solvay Process (commercial preparation of Na_2CO_3)

52. water hardness

GO ON TO THE NEXT PAGE.

B - TEXTBOOKS

Indicate, by blackening the appropriate boxes in the TEXTBOOKS section of the Response Sheet, the books which you used regularly in high school chemistry courses. In the section headed FIRST CHEMISTRY COURSE, blacken the box in column 1 for the one textbook which was used most frequently in your first chemistry course and blacken the boxes in column 2 for all other secondary or less frequently used texts. If you have taken more than one chemistry course, please repeat this procedure in the section headed SECOND CHEMISTRY COURSE making sure that you mark only one text in column 1.

	Author	Title
1.	Baker, Bradbury, McQuill, and Eichinger	Chemistry and You
2.	Brownlee and others	Elements of Chemistry
3.	Chemical Bond Approach Project (CBA)	Chemical Systems
4.	Chemical Education Material Study (CHEMS)	Chemistry: An Experimental Science
5.	Dorf, Lemklin, and Troils	Chemistry for the Nuclear Age
6.	Dull and others	Modern Chemistry
7.	Fliedner and Teichman	Chemistry: Man's Servant
8.	Garrett, Richardson, and Kiefer	Chemistry: A First Course in Modern Chemistry
9.	Hogg, Alley, and Bickel	Chemistry: A Basic Science
10.	Hogg, Bickel, and Little	Physics and Chemistry: A Unified Approach
11.	Jaffee	New World of Chemistry
12.	Kennan and Wood	General College Chemistry
13.	Lanford	Using Chemistry
14.	Lemkin	Graphic Survey of Chemistry
15.	Nebergall and Schmidt	General Chemistry
16.	Pauling	College Chemistry
17.	Quagliano	Chemistry
18.	Rawlins, Struble, and Gatewood	Chemistry in Action
19.	Sienko and Plane	Chemistry
20.	Sisler, Vander Werf, and Davidson	College Chemistry: A Systemic Approach
21.	Sturchio, Mechamkin, Dorfman	Chemistry: Principles and Concepts
22.	Weaver and Foster	Chemistry for Our Times
23.	Woodburn	Excursions into Chemistry
24.	Young and Petty	Chemistry for Progress

25. Other (Blacken box 25 and specify the title and author of your text at the end of the TEXTBOOKS section of the Response Sheet.)

C - OTHER

1. Approximately how much time per week, on the average, did you spend in laboratory work in your first course in chemistry? Consider that laboratory work means making observations or conducting experiments on your own, or with a partner, or with a small group of fellow students.

A. None
B. 30 minutes or less
C. About 45 minutes
D. About 1 hour
E. About 1½ hours
F. About 2 hours
G. More than 2 hours

2. What was the average number of class periods a week that your class met in your first course in chemistry including time spent on laboratory work? If the class met for one or more double periods, count them according to the number of equivalent single periods.

A. Three or fewer
B. Four
C. Five
D. Six
E. Seven
F. Eight
G. Nine
H. Ten
I. Eleven or more

3. What was the average length of a single class period in your first chemistry course?

A. Less than 40 minutes
B. 40 to 49 minutes
C. 50 to 59 minutes
D. 60 minutes or more

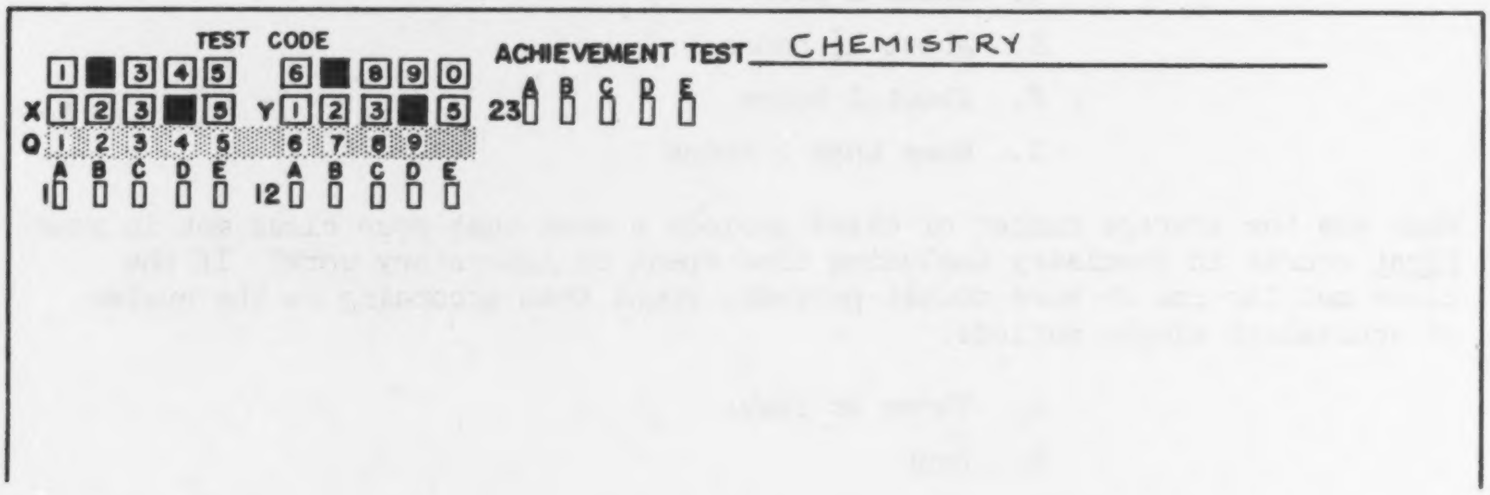
THANK YOU FOR YOUR COOPERATION

Appendix III

CHEMISTRY TEST

The top portion of the section of the answer sheet which you will use in taking the Chemistry test must be filled in exactly as shown in the illustration below. Note carefully that you have to do all of the following on your answer sheet:

1. **Print CHEMISTRY on the line to the right of the words "Achievement Test."**
2. **Blacken spaces 2 and 7 in the row of spaces immediately under the words "Test Code."**
3. **Blacken space 4 in the group of five spaces labeled X.**
4. **Blacken space 4 in the group of five spaces labeled Y.**


TEST CODE
1 ■ 3 4 5 6 ■ 8 9 0
X 1 2 3 ■ 5
Y 1 2 3 ■ 5
Q 1 2 3 4 5 6 7 8 9
ACHIEVEMENT TEST CHEMISTRY
23 A B C D E
1 A B C D E
12 A B C D E

In the group of nine spaces labeled Q, you are to blacken ONE and ONLY ONE space, as described below, to indicate how you obtained your knowledge of chemistry. The information that you provide will not influence your score on the test.

Space 1. I am now taking, or have taken, the chemistry course known as the Chemical Bond Approach Course (CBA). (If this applies to you, the symbol shown at the right will be familiar to you and you will have used either paper-covered textbooks with pages the same size as those in this test booklet or a hard-covered textbook titled Chemical Systems.)

Covalent
Ionic
Metallic

Space 2. I am now taking, or have taken, the chemistry course known as the Chemical Education Material Study Course (CHEM Study). (If this applies to you, the symbol shown at the right will be familiar to you and you will have used either paper-covered textbooks with pages the same size as those in this test booklet or a hard-covered textbook titled Chemistry: An Experimental Science.)

CH
EM

Space 3. I am not sure if I am taking, or have taken, either the CBA or the CHEM Study Course.

Space 4. I am not taking, or have not taken, either the CBA or the CHEM Study Course.

Spaces 5-9. These spaces are to be left blank.

When the supervisor gives the signal, turn the page and begin the Chemistry test. There are 100 numbered spaces on the answer sheet and 90 questions in the Chemistry test. Therefore, use only spaces 1 to 90 for recording your answers.